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Skyways

Flight Operations • Engineering • Management

DECEMBER 1954

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Economic Aspects of Jet Transport Operations

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Boundary-Layer Control

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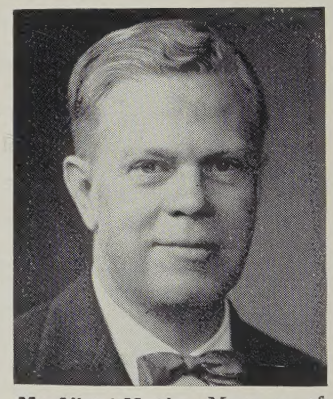
Round Table: Problems in Braking Military & Civil Aircraft

Atlantic Aviation opens new division at Philadelphia International Airport!

At Philadelphia, as at every other division, Atlantic Aviation specializes in meeting the needs of executive flyers and aircraft with prompt, courteous service.



Mr. Albert Mosley, Manager of Atlantic Aviation, Phila., Pa.

keeps 'em flying with Esso Aviation Products!

Atlantic Aviation, "the east coast's complete aeronautical service" uses Esso Aviation Products exclusively at its newest division located at the Philadelphia International Airport. With complete shop, storage, and servicing facilities, Atlantic specializes in meeting the needs of executive aircraft and flyers with efficient service . . . dependable, high quality Esso Aviation fuels and lubricants.

For quality and service you can always depend on Esso Aviation Products. There are hundreds of Esso Dealer Airports ready to supply your private or company plane with a complete line of high quality fuels and lubricants. Esso Aviation Products have been proved for over 44 years of actual flying.

For extra convenience take along an Esso Credit Card. You and your company can charge, in addition to gasoline, lubrication, tire and battery services, over-night storage in transit, and minor emergency repairs. Look for the famous Esso Wings for quality, service and convenience.

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The principle of electrothermal de-icing was developed by the National Research Council of Canada. The difficult propeller application was solved through the pioneering teamwork of Goodyear and Hamilton Standard of Windsor Locks, Connecticut. *Goodyear—a great name to work with TO GET RESULTS!*

Ten years ago, Hamilton Standard and Goodyear joined forces to do battle with ice—long a bitter enemy of the aircraft propeller.

It was pioneering effort which overcame technical difficulties that for years had stumped every aeronautical engineer who had sought a foolproof method for de-icing the whirling blades.

Out of this teamwork, the blade Iceguard was born—a new electrothermal system utilizing thin plies of electrically conductive rubber, power-fed by fatigue-resistant braided wire leads from a unique "pigtail" power connection.

THIN, the Iceguard conformed readily to blade contours — maintained the aerodynamic contour of the propeller. TOUGH, the homogeneous structure of the conductive rubber resisted rain and erosion—increased life of the de-icing equipment. EXTREMELY EFFICIENT, the Iceguard proved to be the most nearly perfect sheet-type heater because the thermal gradient across the heater is minimized.

And above all, RELIABLE. Today, as a result of the continued design and test work by Hamilton Standard, Goodyear and the help of the National Research Council of Canada, these famous propellers equipped *with Iceguards have logged 20 billion blade air miles and 65 million blade flying hours in actual service!*

It is convincing proof of performance, a tribute to Hamilton Standard's pioneering leadership—the kind which has placed their blades "out front" on the finest, fastest reciprocating-engine aircraft in the world!

Goodyear, Aviation Products Division,
Akron 16, Ohio or Los Angeles 54, California

Iceguard—T. M. The Goodyear Tire & Rubber Company, Akron, Ohio

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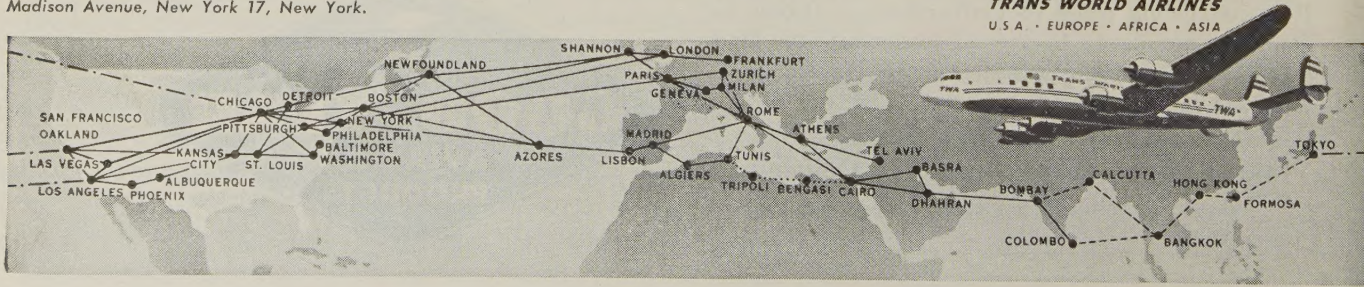
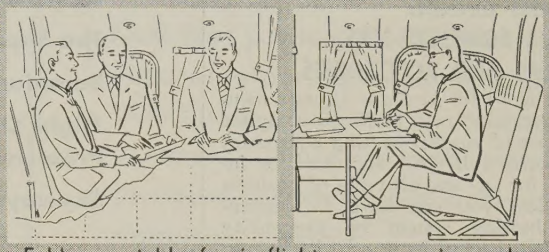


flexibility in the new AERO Commander 560

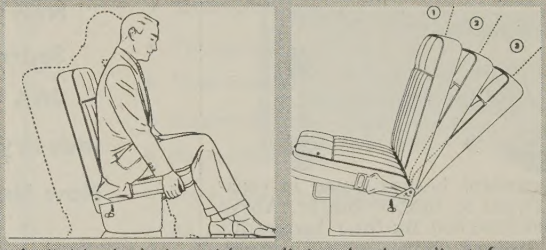
Flexibility of cabin arrangement is another comfort advantage the Aero Commander 560 brings to the flying executive.

Pictured here are but a few of the optional features made possible by the long, wide cabin of this twin-engine business airplane.

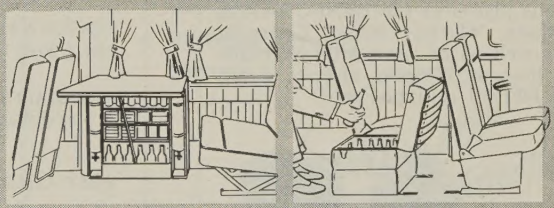
Hassock seat and lowered chair back form comfortable full length couch.



Fold-away table for in-flight use — work, cards, lunch.



Individual chairs with reclining backs adjust fore and aft for added comfort — leg room.



Snack bar and hassock seat ice box are convenient for long hops.

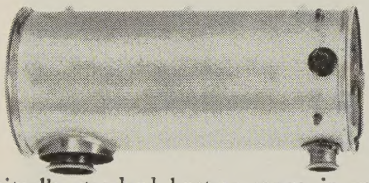
WRITE
DEPT. 126
FOR NEW
CATALOGUE

AERO DESIGN Commander 560

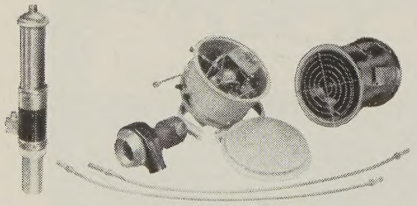
AERO DESIGN AND ENGINEERING COMPANY • TULAKES AIRPORT, P. O. BOX 118 • BETHANY, OKLAHOMA

for business aircraft:
JANITROL'S COMPLETE LINE OF HEATERS AND ACCESSORIES

Here's hot news for business aircraft owners and operators! . . . Janitrol's complete *standard* line of aircraft heating equipment and accessories (all CAA approved for installation) for any and all types of business aircraft. Now you can have a "custom-tailored" heating system by assembling **standard units** backed by standard parts out of our warehouse stocks.



Janitrol's standard heaters range in capacity from 25,000 to 200,000 Btu/hr. Above is the S-200 (200,000 Btu/hr.) heater. It's typical of Janitrol design, proven dependability, and long life. Thousands of Janitrol heaters are already performing on such famous planes as the DC-6's, DC-7's, Constellations, Martin 404's, Convairs, DC-3's, as well as on most military transports. A host of business aircraft flying today are Janitrol equipped too!



This typical group of Janitrol heater accessories includes Blowers, Fuel Control cans, Ignition units, Shielded leads, Clamp bands and Flanges . . . everything needed to complete your heating system, all matched for best service, installation simplicity, interchangeability, and accessibility.

When you need aircraft heating . . . no kidding . . . we've got experience, proven products, and installation data to do the job right on most anything that flies! Ask your local modification center, or write me for the address of your nearest Janitrol district office.

Cordially:

Joe

Janitrol Aircraft-Automotive Division, Surface Combustion Corporation, Columbus 16, Ohio.

DECEMBER, 1954

Skyways

Flight Operations • Engineering • Management

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SKYWAYS is the authorized publication of the National Business Aircraft Association.

VOLUME 13, NUMBER 12

SKYWAYS is published monthly by Henry Publishing Co. for Skyways Publishing Corp. Publication office: P. O. Box 841, Bristol, Conn. Editorial and business offices at 444 Madison Avenue, New York 22, N.Y. Address all correspondence to 444 Madison Avenue, New York 22, N.Y. Printed in the U. S. A. Single copy; 50¢. Subscription Prices. U. S., Possessions, Canada and Pan Am. Union, $9.00 for 3 years, $7.00 for 2 years, $4.00 for 1 year; all other countries add $1.50 per year for postage. Please give title, position and company connection when subscribing. Six weeks required for address changes (give both old and new). Manuscripts, drawings, other material must be accompanied by stamped, self-addressed envelope. SKYWAYS is not responsible for unsolicited materials. Entered as second-class matter, October 19, 1954 at the post office at Bristol, Conn., under act of March 3, 1879. Copyright 1954 by Henry Publishing Company. The following publications are combined with SKYWAYS; Air News, Flying Sportsman and Airways Traveler. All rights to these names reserved by Skyways Publishing Corporation.

industry notes . . .

■ Los Angeles Airways, Inc. has awarded The Garrett Corporation's AiResearch Aviation Service Company a contract for conversion of four Sikorsky S-55 helicopters to passenger-carrying craft. The passenger version of the helicopter, heretofore used by Los Angeles Airways for cargo only, will have seven seats. Interior walls of the helicopters are being covered with a washable Vinyl material, laid over a lightweight soundproof padding of Fiberglas.

■ The R3Y-2 turboprop seaplane being built by Convair for the U. S. Navy made its initial flight recently. Piloted by Don P. Germeraad, Convair's chief engineering test pilot for Navy projects, and a crew of five, the big pressurized seaplane logged one hour and 23 minutes on its first flight. Like an LST, the R3Y-2 is designed to land guns, trucks, small tanks, troops and cargo directly on beaches.

■ Swissair, the airline of Switzerland, recently ordered two DC-7C's for operation over Swissair's transatlantic route between New York and Zurich, non-stop. The DC-7C's are expected to go into scheduled service in 1957.

■ The Air Force has awarded Lear, Inc. a $3 million contract for an initial quantity of a new Lear autopilot designated MB-2 by the Air Force. The autopilots are to be installed in Republic F-84F *Thunderstreak* jet fighters.

■ Design-study contracts for one-man helicopters have been awarded to Hiller Helicopters, Gyrodyne, and Kellett by the Navy's Bureau of Aeronautics.

■ Federal Telephone & Radio Co., of Clifton, N. J., has organized an instrument division which will develop and produce communication test equipment, standard capacitors, insulation test equipment, and laboratory and industrial electronic testing devices.

■ McDonnell Aircraft recently received a $38,700,000 contract from the U.S. Navy for development of an advanced all-weather attack fighter. This new contract represents McDonnell's first design entrance into the field of attack-type aircraft.

■ Bell Aircraft Corporation's Helicopter Division has received a contract to inspect and repair "as necessary" 70 of the Army's H-13 Bell copters. The IRAN contract calls for this work to be done at Bell's Fort Worth facilities.

■ Taylorcraft, Inc. recently flew its Fiberglas-reinforced plastic lightplane for the first time. In addition to fuselage and wings, the plane's seats, doors, gas tanks, wheel pants, cowl, and instrument panel also are made of the Fiberglas-reinforced plastic. Only the rudder and elevator are covered with fabric. The plane is 24 feet long, has a 36-foot wing span, weighs about 1300 pounds, is powered by 145-hp engine, and will sell for around $6,000; the model powered by a 225-hp engine will be about $9,000.

■ Beech Aircraft has completed contract negotiations with Lockheed for the manufacture of a quantity of USAF T-33 wings. Dollar volume of this newest supplemental production contract amounts to more than $1,800,000, and will extend production of the Lockheed T-33 jet wings into the fall of 1955.

■ Monocoupe Aircraft of Florida, Inc. is presently setting up its dealer and distributor organization for the sale of its four-place, all-metal *Meteor* powered by 150-hp Lycoming engine. Evaluation and certification tests are underway, and full specs and performance data are expected to be released soon. Plans call for delivery of the *Meteor* at $25,000 FAF, with Stewart-Warner heater, instruments and radio for all-weather flying.

■ Hiller Helicopters has sold another three-place 12-B helicopter to Philippine Air Lines. The airline has five Hillers being used as passenger carriers and for all types of charter work.

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Next time you land at Miami's International Airport taxi directly to the 20th Street area and the Aerodex Customer Service Terminal where courteous service — plus a hearty welcome—is yours!

- **Air-conditioned Club Lounge**
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Aircraft and Engine Sales

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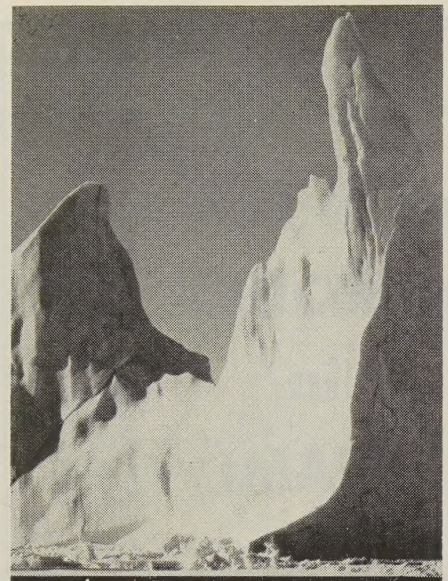

With airplanes, as with icebergs, it's the hidden nine-tenths that causes the trouble.

In airborne electronic equipment, reliability and continuity of service depend on the detection of trouble before it manifests itself in unit failure. With planes, or with icebergs, it's rash to gamble when the odds are stacked against you.

Preventive maintenance is an essential part of airplane upkeep. The discovery of minor defects *before* they develop into major trouble spots is the purpose of periodic checks.

The Electronic Division of Reading Aviation Service, Inc., is fully equipped and staffed to service all types of electronic equipment.

To steer a safe course, take a heading for READING!

READING HAS MORE TO OFFER

RAS INCORPORATED

READING
AVIATION SERVICE, INC.
Municipal Airport • Reading, Pa.

now hear this . . .

PERSONNEL

Dr. Louis G. Dunn, Dr. Milton U. Clauser and **Dr. James C. Fletcher,** all guided missile scientists, have joined The Ramo-Wooldridge Corp., a Los Angeles affiliate of Thompson Products, Inc., Cleveland. Dr. Dunn is Associate Director of Guided Missile Research Division; Dr. Clauser is Director of Aeronautics and Structures staff; and Dr. Fletcher is Director of Guidance and Control staff.

James L. Murray and **Emery M. Ellingson** have been named Assistants to the President of The Garrett Corporation.

Clifton T. Foss recently was named Assistant General Manager of Arma Div., American Bosch Arma Corp. Mr. Foss also continues as Vice President-Engineering of the Division.

H. Webster Crum has been appointed Vice President and General Sales Manager of Lycoming Division of Avco Manufacturing Corp.

Rowland Burnstan is new president of Borg-Warner International Corp.

Robert L. Earle has been named Executive Vice President of Marquardt Aircraft Co., Van Nuys, Calif.

Carleton Putnam has resigned as Chairman of the Board of Delta-C&S Air Lines, but continues to serve as a director.

Arthur S. Locke has been named Associate Director of the West Orange (N. J.) Laboratory of Vitro Corporation of America. Mr. Locke is an expert on guided missiles and fire-control equipment and for the past eight years has been a consultant in the radar division of the Naval Research Laboratory in Washington, D. C.

Herrol Bellomy was named Executive Vice President and General Manager of the L. B. Smith Aircraft Corp. and Aerosmith, Inc., at Miami International Airport.

N. A. Lamberti has been named staff assistant to George Otis, Vice President of Lear, Inc., and General Manager of LearCal.

James P. Buckley recently was appointed Regional Sales Manager on the West Coast for four divisions of Bendix Aviation Corporation.

Everett Badger has been named fuel system specialist by Accessory Products Corp., Whittier, Calif.

William S. Oman was appointed Director of Sales for Com-Air Products, Inc., Los Angeles.

K. J. Bigelow has been appointed manager of Allison's Dayton Zone Office.

Jack C. Charleson was elected to the Board of Directors and named Managing Director of United Helicopters Ltd., a wholly owned subsidiary of Okanagan Helicopters Ltd.

George W. Craig recently joined Camair, Galveston, as Chief Engineer.

Herbert M. Bradbury was appointed Manager of Customer Service of Aerodex, Inc., Miami. Mr. Bradbury also will continue as Director of Development and Engineering for Aerodex.

Howard R. Donalson has been promoted to Assistant Operations Manager of Riddle Airlines. He was formerly superintendent of stations for Riddle.

Marvin W. Nolan has been named Director of Military Transportation for Southern Airways, Inc. **Harold Goodson** has been promoted to District Sales Manager—Atlanta for Southern. **Capt. William S. Magill** has been promoted to Director of Operations.

W. J. Kinsey has been appointed Sales Manager of Engine Controls for General Electric's Aircraft Products Department.

Arthur E. Harrison has been made Director of Engineering for Fairchild Guided Missiles Div.

George Ledbetter recently was named Southern California representative for United Control Corporation.

Buell A. Patterson has joined McCann-Erickson, Inc., to handle public relations for Vickers-Armstrongs, Ltd., of England.

James E. Knott has been appointed Assistant Manager of the Aircraft Sales and Contracts Department of Allison Division of General Motors.

COMPANIES

J. F. Mohan and Charles Kamerer, formerly of Republic Aviation Corp., have announced the formation of **Mohan, Kamerer & Co., Inc.,** to offer both sales engineering and contract management services to the aircraft industry.

Trans-International Airlines, Inc., a division of Leeward Aeronautical, have opened an office at Love Field, Dallas, to handle special, charter and lease flights throughout the Southwest.

Formation of **Fairchild Kinetics Division** has been announced by Fairchild Engine and Airplane Corporation. Offices are at 1860 Broadway, New York City. Alfred A. Gassner is general manager.

The BG Corporation has moved from 136 W. 52nd St., New York, to 321 Broad Avenue, Ridgefield, N. J.

Garrett Corporation has announced the establishment of a Columbus, Ohio branch office of its Aero Engineering Division, Mineola, L. I. Walter L. Clark has been placed in charge of the Columbus office.

AERO CALENDAR

Nov. 30-Dec. 3—American Rocket Society annual meeting, Hotel McAlpin, New York.

Dec. 17—IAS Eighteenth Wright Brothers Lecture, U. S. Chamber of Commerce Bldg. Auditorium, Washington, D. C.

Dec. 17—Wright Brothers Dinner, Statler Hotel, Washington, D. C.

Dec. 20—Eighteenth Wright Brothers Lecture (Repeated), Los Angeles.

Dec. 22—Eighteenth Wright Brothers Lecture (Repeated), Cleveland.

Jan. 19-23—World Trade Fair of Aviation, Miami International Airport, Miami.

Jan. 24-27—Plant Maintenance & Engineering Show, International Amphitheatre, Chicago.

Jan. 24-28—Twenty-third Annual Meeting and Honors Night Dinner, IAS. Hotel Astor, New York City.

Mar. 11—National Flight Propulsion Meeting (Restricted), IAS. Hotel Carter, Cleveland, Ohio.

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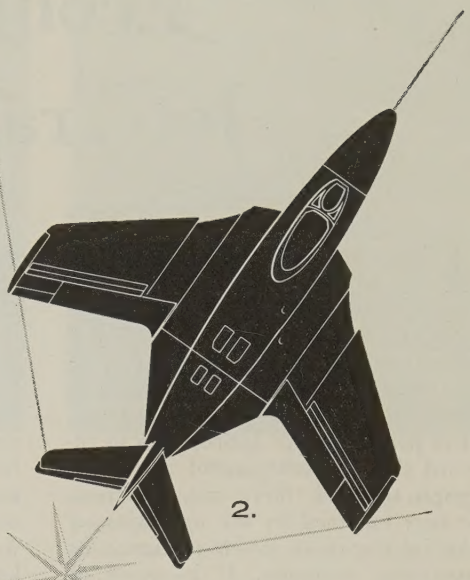

2.

3.

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To make you a highly skilled Naval aviator, the United States Navy will give you education and training worth $64,000. To give you the finest aircraft, the Navy has over the last 25 years selected designers and builders like Grumman. For a career in the Navy, ask any recruiting officer about the NAVCAD program.

GRUMMAN AIRCRAFT ENGINEERING CORPORATION

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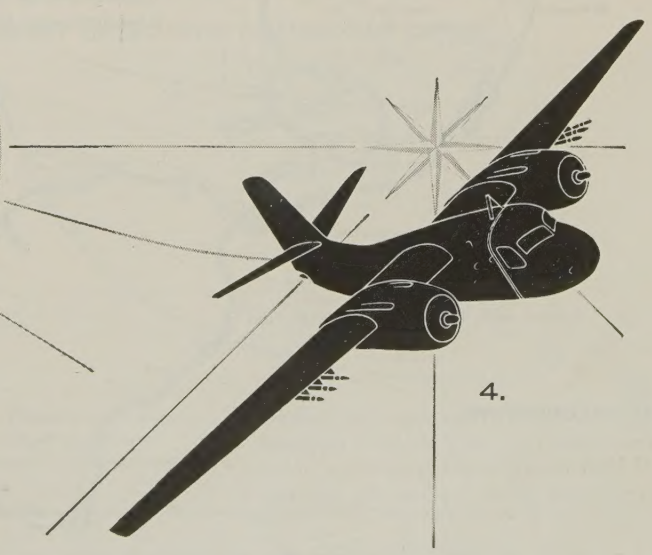


4.

by George W. Westphal
Preliminary Design Engineer
Fairchild Aircraft Division

Economic Aspects of Jet-Transport Operation

There are numerous factors involved in considering the economic aspects of jet-transport operation. Many of these are not visible in a computation of direct operating costs but nevertheless have a pronounced influence on such costs. It is perhaps more appropriate to reword the first sentence of this paragraph to read, *there are numerous factors involved in the operation of the jet transport which influence its operating economy.* It is some of these considerations that we are concerned with here.

The turbojet, in particular, has taken quite a beating from the standpoint of operating economy. In considering this economy, it must be remembered that with turbine-powered transports we are entering a new era in air transportation. It is going to affect the habits, the operating tempo, the thinking and possibly the disposition of everyone from the president to the office boy. Streamlining of the jet transport to give it a speed which will bring operating economy will be to no avail unless we also streamline our operations in keeping with this increased speed.

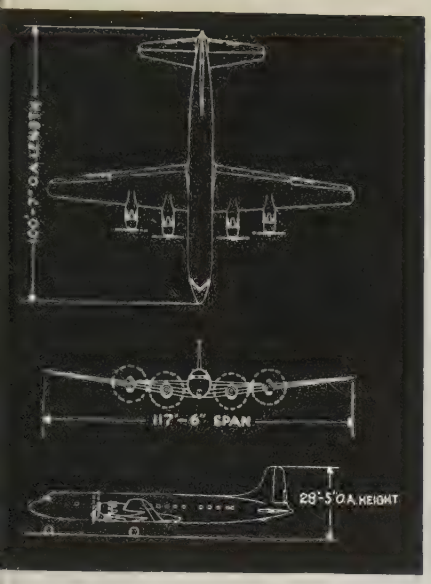
Lt. Gen. Joseph Smith, USAF, presented a paper at a meeting of the Washington (D.C.) Section of the Institute of the Aeronautical Sciences in 1953 in which he stated, ". . . I do not believe that many of us realize that perhaps we are not as ready for the jet transport as it is ready for us."

This still seems to be generally true. An excellent example of this concerns the matter of reserve fuel required for trips of 300 miles or more (domestic operation). The Air Transport Association currently requires adequate fuel reserve for 300 miles plus one hour. This reserve is used in computing and analyzing the general operational characteristics of aircraft on a comparative basis. The airlines compute reserve based on their particular route structure in conjunction with the current CAA minimum requirement for fuel from destination to most distante route alternate plus 45 minutes (at cruise speed) for short-range operation, or two hours for long-range with due regard for wind and weather conditions. For jet types, however, there has been some talk of a 45-minute hold at 20,000 feet, descent to about 5,000 feet, climb back and cruise to an alternate airport 300 miles away, another 45-minute hold, then descent, final approach and landing. At a ground speed of 520 mph this reserve would be sufficient for approximately 1,080 miles. How preposterous can we get, particularly for domestic operation!

Consider a transcontinental trip from New York to Los Angeles with an intermediate stop at Chicago. The airline distance from New York to Chicago is approximately 710 miles, and from Chicago to Los Angeles is about 1740 miles. At a ground speed of 520 mph at 45,000 feet the block time for a typical proposed turbojet transport is 1 hour 30 minutes for the first stage and 3 hours 30 minutes for the second stage. Are either of these periods so long that it is not possible to know before departure, or at least very early enroute, whether a landing can be effected at the intended destination or whether it will be necessary to proceed to an alternate airport? If the answer is

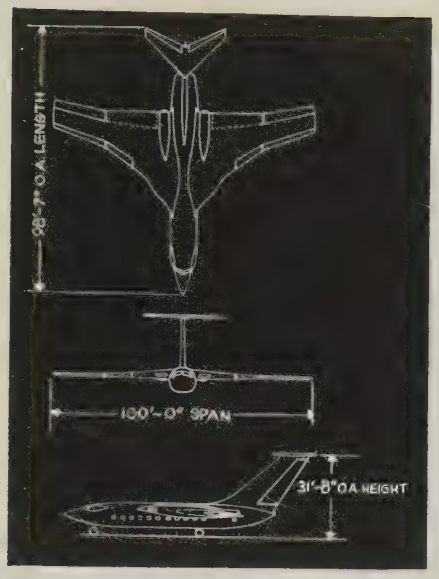
TRANSCONTINENTAL *operation of a turbojet transport such as Fairchild's projected M-186B design would require use of external fuel if trip were to be non stop*

3-VIEW COMPARISON



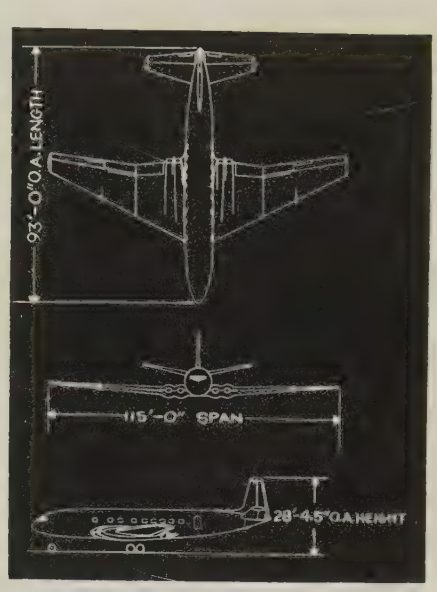
DC-6B

Gross Weight	100,000 lbs.
Passengers	44 - 88
Cruise Speed	315 mph
Cargo Space	4433 cu. ft.



M-186B

Gross Weight	75,000 to 100,000 lbs.
Passengers	44 - 64
Cruise Speed	563 mph
Cargo Space	2700 cu. ft.



D. H. COMET-2

Gross Weight	120,000 lbs.
Passengers	44
Cruise Speed	490 mph
Cargo Space	2478 cu. ft.

"yes," then here is one phase of the operation which requires revision to provide faster and more accurate forecasts of temperature, wind velocities and weather. For economical operation the turbine-powered airplane cannot afford to be burdened with excessive reserves which eat into revenue-earning payload. This is particularly true of the turbojet.

Safety

Streamlining of those items which affect the safety of jet-transport operation will be in order. This refers to such things as weather forecasting, air traffic control, navigational aids, dispatching, etc.

Weather Forecasting: The increased operating speeds, utilization and longer ranges associated with the jet transport mean that they will be flying more weather and coping with some of the problems peculiar to flight at higher altitudes. For example, the turbulence sometimes associated with crossing a jet stream area can be sudden, quite severe and of a nature not conducive to peace of mind for the average passenger. Quite obviously, the best way to keep out of it is to avoid it altogether. This means that more accurate and accelerated forecasts of high-altitude conditions will be necessary.

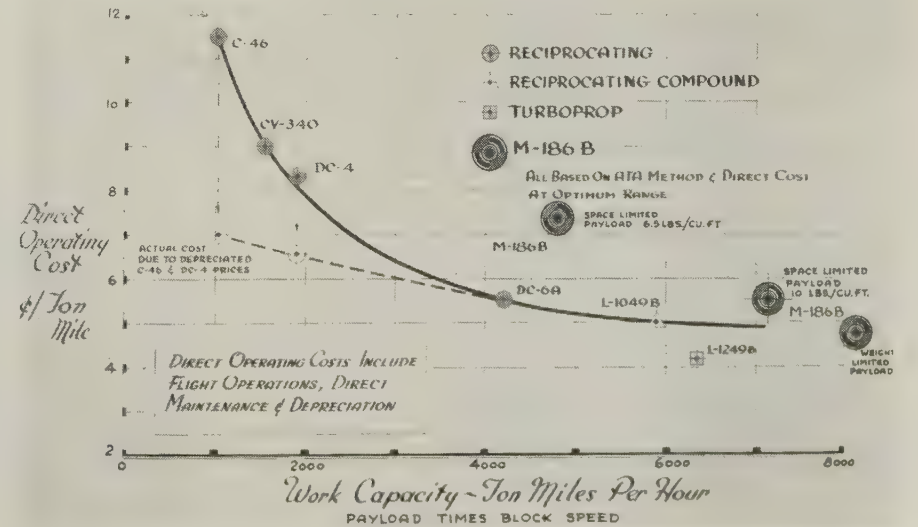
From a safety standpoint the transmittal of accurate and frequent information to the crew becomes of prime importance. This is necessary to keep the crewmen informed of changing conditions along the way (wind, visibility, etc.) and becomes of particular importance during deteriorating weather at point of destination. The matter of existing practices (and it happens all too frequently) whereby a flight scheduled to land at New York, upon arrival over LaGuardia is diverted to Philadelphia, then to Washington, thence to Pittsburgh and finally ends up in Columbus, cannot be permitted if jets are to be operated economically.

Weather information services and the communications associated therewith must be accelerated and synchronized so as to provide more comprehensive information on which to base flight plans from the outset. In the interest of safety and economy it may be feasible for intermediate ground stations to keep up a running account of terminal and alternate weather conditions so the pilot may know whether it is possible for him to land at the intended destination or whether he must divert to an alternate airport. The further out the jet transport can be diverted the more economically an alternate flight path can be planned and executed.

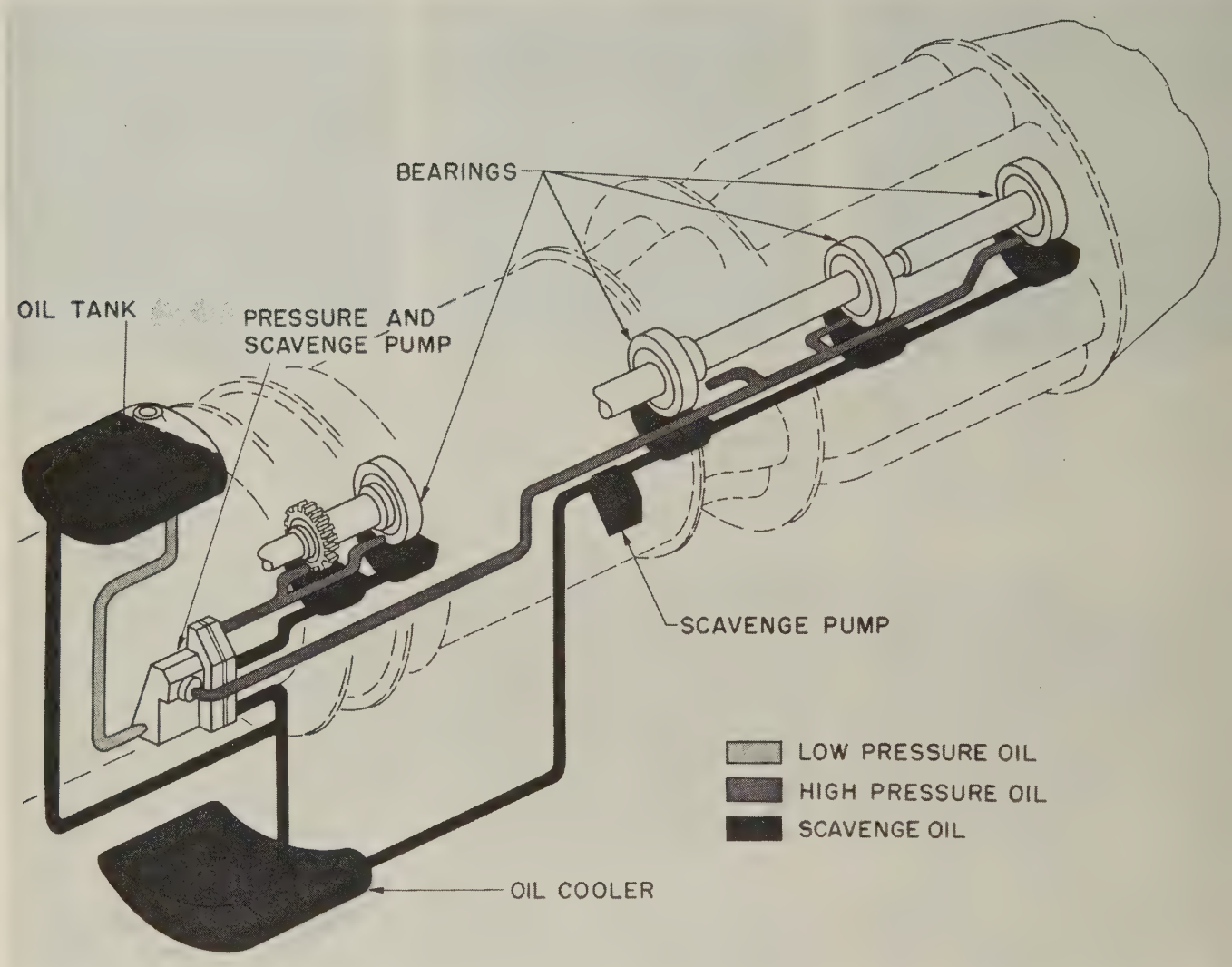
Accelerated weather forecasting becomes an all-inclusive and vital factor since it affects navigation, communications, fuel reserves and

(*Continued on page* 28)

DIRECT OPERATING COSTS COMPARISON



Synthetic Oils for Turbine Lubrication



▲ **FIGURE 1**—*Lubrication system of a typical turbojet engine.*

by H. A. Murray

Research and Technicolor Dept.,
The Texas Co.

Part 1 of a two-part article which details aircraft turbine lubrication systems, requirements, properties of synthetic oils

Compared with piston engines, the lubrication systems of turbojet and turboprop engines are quite simple. The essential components requiring lubrication in the turbojet engine are main shaft bearings and accessory drive gears. In some engines, the lubricant also serves as a hydraulic fluid for actuating fuel controls.

Ball and roller bearings have replaced plain bearings in virtually all cases for main shaft and accessory drive shafts. The advantages realized with former class of bearings in these locations are: lower starting torque, ability to operate for short periods without a continuous oil supply, reliable operation with low viscosity oils and more suitable for high temperatures.

In turboprop engines, the reduction gear must be included among the important components requiring lubrication. In current engines, these gears are supported by sleeve type or ball bearings.

Oil for actuating propellers may be supplied from the main engine supply or from a separate system carried within the propeller hub. The propeller requirements,

therefore, may play a part in the selection of type of oil for the turbine.

The dry sump system generally is used for gas turbine powerplants, similar in many respects to the large piston engine. Oil usually is carried in an external tank. Some turbines, however, utilize the lower portion of the accessory case for the oil reservoir. The tank may be mounted on the outside of the turbine or elsewhere in the engine nacelle or wing.

Oil enters the pressure pump from the tank or reservoir. From the pump oil usually passes through a fine mesh strainer or filter and then branches out to each bearing and coupling on the main shaft as well as to various jets in the accessory section. An orifice usually is placed in each supply line to meter or proportion the flow to each component or assembly. In a majority of turbines, the supply of oil to the main bearings is in the form of steady jet from small nozzles. This oil then is scavenged from each bearing housing and returned to a heat exchanger and tank.

In some engines, the oil supply to the main bearings is metered either directly into the bearing or into a cooling air stream where it is atomized. With the metered supply the excess is allowed to drain overboard.

Lubrication of the reduction gear assembly in turboprop engines follows piston engine practice rather closely.

Compared with piston engines, the heat rejection to lubricating oil in turbojet engines as a function of fuel flow is relatively small. Consequently, it is possible to transfer this heat to the fuel supplied to the engine. This method of utilizing fuel for oil cooling is now proving quite successful in modern high-speed aircraft.

Heat rejection to oil in turboprop engines is much greater than with turbojet due to the reduction gear. Slower speeds of such aircraft and higher heat rejection rates favor the conventional oil cooler similar to those used with piston engines.

General Lubrication Requirements

Of the numerous requirements for an aircraft turbine lubricant, perhaps the following represent the three most important:

1. Low temperature fluidity
2. High temperature stability
3. Gear lubrication

Other requirements that also must be taken into consideration are compatibility with metals, volatility, hydrolytic stability, toxicity, availability and cost.

Low Temperature Requirement

A turbine lubricant must permit starting on the ground or in flight at the lowest anticipated temperature. While preheating and dilution of lubricating oils are accepted for piston engines, they are not favored for the military aircraft turbine at the present time. Dilution of lubricating oil is more or less impractical due to lower volatility of fuel and insufficient heat in most turbines to boil off the diluent. Another possible objection to dilution might be found in the loss of diluent in certain regions due to high temperatures following shutdown. Since most turbines can be designed to operate successfully on low viscosity oils, there is probably little reason to call upon these starting aids. The first requirement then is for the lubricant to be capable of pumping at the lowest starting temperature.

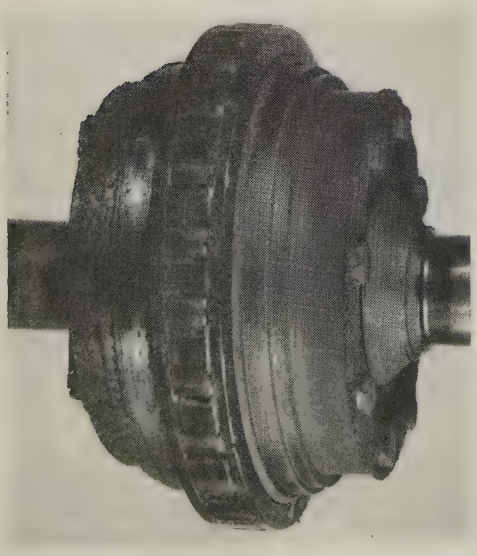
There are two different viewpoints on this requirement. First, the U. S. Military Services specify —65°F. and second, the British —40°F. as the minimum starting temperatures. In many cases these requirements are not interchangeable. Lubricants developed to meet the —65°F. requirement cannot be used successfully in most turbines designed to meet the —40°F. starting temperature. It also is quite apparent that the reverse invariably holds true, where an oil just meets the pumpability requirements of —40°F., it cannot meet the —65°F. requirement. Two entirely different synthetic lubricants are required, one for U. S. Military (—65°F.) and a second for the British (—40°F.).

Operation of military aircraft over the North American Continent during the past 12 or 13 years has stressed the need for meeting the —65°F. starting temperature requirement for this particular area. Restarting of turbines in flight with multi-engine aircraft may impose even lower starting temperature requirements than the —65°F. ground starting condition.

In the case of civil or commercial operations, this requirement may be somewhat milder. Present experience seems to indicate that a minimum starting temperature of —40°F. will suffice for all except a few rare cases.

Low temperature pumpability tests in the United States and Great Britain show unusually good agreement with regard to the maximum permissible viscosity. This varies from one installation to another according to design of engine, oil tank location, plumbing, etc.

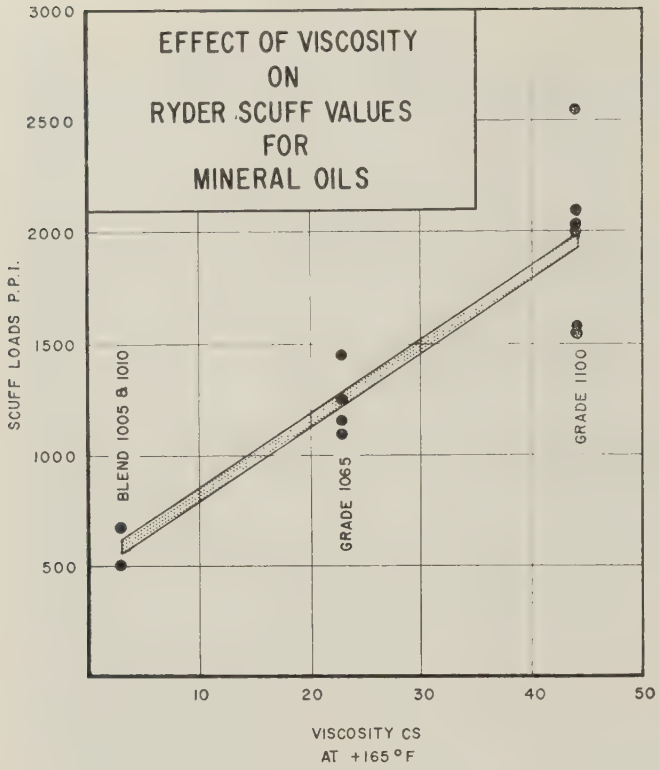
Low temperature pumpability tests conducted recently by the Aeronautical Engine Laboratory of the U. S. Navy



AIRCRAFT *turbine bearing (left) was given a high-temperature accelerated test with MIL-L-7808 type of synthetic oil at 700° F.*

DEPOSITS *(right) were found in this oil line of high-temperature bearing test machine after operation on silicate ester blend*

FIGURE 2



Bureau of Aeronautics with a simulated oil system revealed the following.

With a constant displacement pump, aerated and deaerated oils, pressure altitudes from sea level to 70,000 feet and temperatures from 40°F. to —70°F.:

(a) Pumpability is a function of viscosity, absolute pump inlet pressure, and amount of aeration of the oil.

(b) The configuration of lines on the discharge side of the pump has little or no effect upon the pumpability characteristics of the oil.

(c) The critical viscosity for deaerated oil at sea level for full flow was approximately 6,000 cs. For aerated oil the critical viscosity was approximately 3900 cs. At higher viscosities pump cavitation occurred and delivery rates decreased with increase in viscosity. The maximum permissible viscosity for satisfactory starting was estimated to be roughly 10,000 cs.

Some of the early full-scale J-47 low temperature starting tests conducted by General Electric Company with mineral oils also revealed some interesting data. The critical viscosity where pump cavitation began to show up was approximately 2500 cs. At 7500 cs. viscosity pump cavitation was so complete that the oil would not warm up after a reasonable idling period to permit the engine to be run at higher speeds. For reliable engine operation without any restrictions as to speed or length of warm-up, General Electric recommended a maximum viscosity at —65°F. of 3,000 cs. for the J-47 engine.

High Temperature Requirements

The components in a turbine that operate at the highest temperature are the bearings on the main shaft. In addition to these bearings some parts of the engine frame and bearing support housings may also expose lubricating oil to high temperatures.

The maximum operating bearing temperatures in the majority of turbines already in service fall in the range of 250-300°F. With bearings next to the turbine wheel a soak-back effect occurs following shutdown. Heat accumulated in the turbine wheel disk flows into the cooler turbine bearings when oil flow is stopped at time of shutdown. This causes a brief rise of roughly 150°F. and followed by a slow cooling off of the entire engine. The peak temperatures during this brief period frequently reach values between 400-450°F. With low viscosity mineral oils, evaporation of oil during this period is quite rapid. Hence, oil volatility is important. These conditions, however, from a high temperature point of view, are what might be called mild and present no serious problems. In this class of turbine the low viscosity mineral oils have served very well.

In some recent turbines with higher pressure ratios the high temperature requirements are much more severe. Normal bearing temperatures during operation are now reaching as high as 475°F., fully 200°F. higher than in previous turbines. The soak-back effect may add another 100-150°F. for brief periods following shutdown. Thrust bearings opposite the compressor discharge location also may exceed temperatures of 400°F. In addition, parts of the engine frame in this region may run close to 600°F. Unfortunately, the highest gas pressures in the entire cycle are at this location, making it difficult to circulate low pressure cooling air in this region. The simplest approach then is to throw most of the burden of cooling on the lubricating oil. These are some of the reasons for introducing the panel coking test in present MIL-L-7808 synthetic oil specification. Except for the thrust bearing and for gyroscopic loads, loads carried by the main shaft bearings are very light. Fortunately, these gyroscopic loads do not impose a serious problem because of their extremely short duration.

Rotor speeds will vary from 20,000 rpm for smaller turbines to below 7,000 rpm for larger units. DN values (diameter of bore in mm., N = rpm) now are running close to 1,000,000. Future DN values are expected to reach 1,500,000.

A turbine lubricant, therefore, must be thermally stable in bearings operating at 500°F. and shall not form objectionable deposits when in contact with hot surfaces of 600°F. for short periods. Also, it is necessary for a turbine oil to be non-corrosive to the various metals present in bearings and other sections at high temperatures.

Gear Lubrication

The ability to lubricate highly loaded gears is the third important requirement of an aircraft turbine lubricant. Undoubtedly, this requirement is of greater importance in the case of the turboprop engine than with the turbojet. In the former the weight of the reduction gear represents roughly 20% of the powerplant weight. Therefore, the ability to operate at high gear loads means lighter gears and an appreciable saving in weight.

According to E. A. Ryder, a design Hertz stress of 125,000 to 140,000 psi is permissible for aircraft engine gears. In the Ryder gear test machine, a Hertz stress of 125,000 psi is obtained at an indicated load of 1050 lb. per inch width (PPI) of tooth. 140,000 psi Hertz corresponds to 1340 PPI. It is obvious that scuffing values should be greater than 1050 to 1340 for successful performance of a turbine gear box.

Oils having scuff values of 200-700 PPI (*Fig. 2*) in the Ryder gear test rig allow immediate scuffing and scoring. Oils falling in the range of 1000-1400 PPI are found to be borderline. Oils having scuff values of 1700-2250 PPI and upward have been quite satisfactory in the full scale engine.

In the final analysis, most designers want a synthetic turbine lubricant that will match the load carrying property of Grade 1100 Mineral Oil (Specification MIL-O-6082).

(*Continued on page* 52)

NEW FOR '55

MOONEY MARK TWENTY *(top photo) is expected to go into production in January, 1955. Its 170-hp engine is reported to give it a cruising speed of 175 mph.* **RILEY** *'55, also expected to be available soon after January 1, features the new 170-hp Lycoming engine and will cruise at 170 mph on 70% of power at 7,000 ft*

The Mooney *Mark Twenty* is being readied in Kerrville, Texas, for its final stages of Type Certification testing. A four-place, high-performance airplane designed for the businessman-pilot, the *Mark Twenty* now features an enlarged cabin and added power. This prototype was shown to NBAA members attending their organization's convention in Dallas. At that time it was announced that the *Mark Twenty* with 170-hp engine would cruise at 175 mph at 6500 ft and 70% of power; would have a 1100 fpm rate of climb, a 23,000-ft ceiling, a landing speed of 45 mph; have a useful load of 1100 lbs and a maximum range of 1,020 miles on 52 gallons of gasoline. These performance figures are based upon prototype performance data.

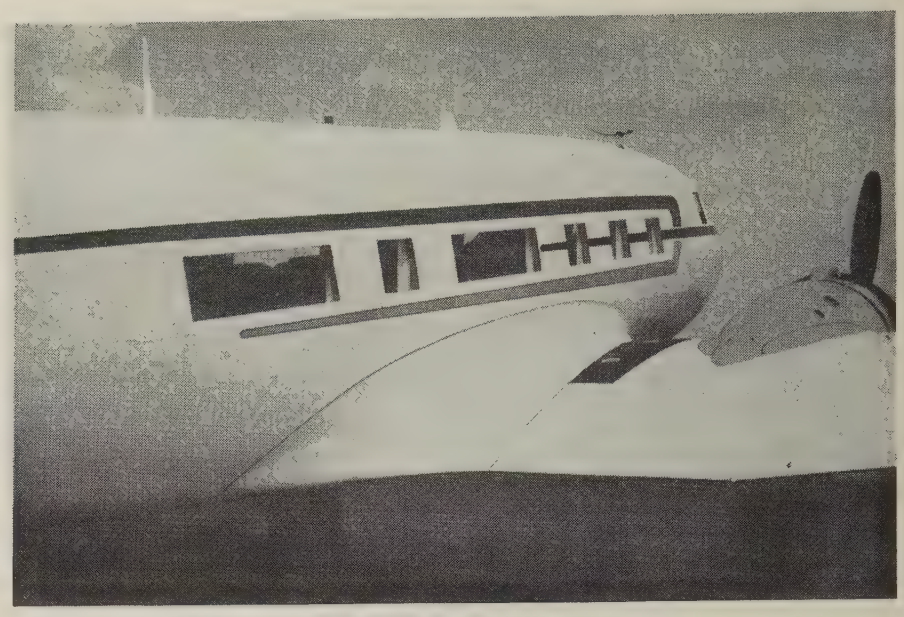
One of the features of the *Mark Twenty* is its laminar-flow wing. According to the Mooney Company, this is the first time the laminar-flow wing has been used on private aircraft. Other features of the Mooney *Mark Twenty* are a mechanically operated retractable tricycle landing gear of exceptionally rugged design, a steerable nosewheel, and a cabin with a low noise level.

Production of this new airplane is scheduled to begin in January, 1955, and the list price for the aircraft has been given as $12,500. This includes a VHF transceiver with Omni, three gasoline tanks with 52 gallons total capacity, all the basic flight instruments and lights, a Hartzell constant-speed metal propeller with Woodward governor and spinner, an outside baggage door, all-weather temperature control, and an all-metal fuselage.

The *Mark Twenty* shown in the photograph above is white with red trim. At the controls is Mooney's Chief Test Pilot Bill Taylor.

Another "new" airplane demonstrated to members of the National Business Aircraft Association at their Dallas convention was the Riley '55, a more powerful version of the Riley *Twin-Navion* conversion done by TEMCO. Improvements over the earlier version of this light-twin include new 170-hp Lycoming engines which provide a top speed of 180 mph and permit a gross weight increase to 3600 lbs; a fuel system which includes bladder fuel cells in the engine nacelles and optional wingtip tanks which stretch the range to 1200 miles; new front seats with foam rubber upholstering to offer greater long-distance comfort; and a redesigned control quadrant. Performance-wise, the Riley '55 offers an empty weight of 2,350 lbs, a gross weight of 3600 lbs, a cruise at 70% of power at 7,000 ft of 170 mph, a service ceiling (two engines) of 20,000 ft and a single-engine ceiling of from 6,000 to 8,000 ft. Take-off distance (zero wind at gross weight, sea level, over 50-ft obstacle) is 1,150 ft, and the landing distance (zero wind at gross weight, sea level, over 50-ft obstacle) is 1,050 ft. Carrying 160 gallons of fuel and at 70% power, the Riley '55 has a 900-mile range; with 146 gallons of fuel its range is 1200 miles. Fuel consumption is from 8 to 10 gallons per hour per engine.

List price for this conversion is $29,500, with the customer furnishing the airframe. TEMCO expects to begin making deliveries on the first Riley '55 soon after the first of the year. Much depends on the availability of the newly developed Lycoming 170-hp engine. Riley '55's will be marketed by Riley Twin Aircraft Sales Corporation, under contract with TEMCO whose modification center at Greenville, Texas, has been producing *Navion* conversions since April, 1953.



by Herb Fisher

Chief, Aviation Development
Port of New York Authority

THE SUPER -92 DC-3

INTERIOR DESIGN *of the Super – 92 features facing davenports up front, swivel chairs in the center section, and conference table, dictating machine and a tape recorder for passenger use*

Until the promised new multi-engine medium transports designed to meet specific performance requirements of business-aircraft operators are produced and well shaken down, we've got to make-do with what we've got.

How well we are doing with our "make-do" executive fleet is answered daily by the dependable performance of several aircraft types which, although properly labeled obsolescent, are still providing superb utilization.

One of them is the faithful old DC-3 which marked a new milestone in air transportation when it was introduced, served as the backbone of scheduled-airline operations for more than 10 years and is now, in its 18th year of economically useful life, one of the chief workhorses in the utility aircraft field.

The DC-3, known variously down through the years as the C-47, C-49, C-53, C-116, R4D and *Dakota,* has gone through more modifications than any other aircraft in history, but its basic design has never been changed. Rather, changes have been refinements—in windshields, powerplants, and other items—to obtain improved performance.

For example, the Super -92 is a DC-3 incorporating the R1830-92 engine modified in an attempt to give the user the performance of the R-1830-75 and -94 and the reliability and weight of the -92.

The Super -92 executive conversion is a product of Remmert-Werner at Lambert Field, St. Louis, and Bill Remmert contends that it will give the operator an economical cruising speed 10% higher than is possible with the standard -92 powerplant. That, of course, means a cruise of 200 mph or better, if the operator wants it.

Remmert-Werner arrived at the Super -92 installation by combining the -92 crankcase and carburetor system and the new -75 cylinders and high dome pistons. Improvements also have been made in rockers, pins, rings and harnesses. The results, according to Remmert-Werner, are superior cooling and more rugged con-

PILOT COMPARTMENT *is set up according to recommendations of SAE Cockpit Standardization Committee S-7. Here Bill Remmert (right) shows Herb Fisher cockpit check list*

STANDARD *equipment includes baggage compartment kit with tools for any emergency field work on engines, airframe; a set of seals, gaskets, spare pumps, spark plugs, starter, etc.*

struction which, together, permit a normal cruise of 700 hp as against the 550- to 600-hp range of the standard -92. The St. Louis shop points to the higher cruise setting as an important factor in lower maintenance and fuel costs per mile.

Some concern has been expressed by some of my business-pilot friends over the life of the Super -92 at the 700-hp cruise setting, but that concern is not shared by Remmert-Werner.

"The best support I can think of for our setting recommendations," Bill Remmert said during our discussion of this point, "comes from the pilots who follow them and from their overhaul costs, which consistently run lower than those for a regular -92."

He pointed out that several Super -92 pilots run the engines considerably below their capabilities, but that their operating records are no better than those of the 700-hp pilots. The lower setting, he said, sacrifices the additional speed and performance possible with the Super -92 and nullifies the maintenance savings stemming from the higher speeds.

Remmert believes no harm is done in using the lower settings, but he said "it's like buying a seven-room house and then closing off one useful room."

An unusual part of the Super -92 program is Remmert-Werner's offer of an 800-hour guarantee on the engine installation. More than 100 Super -92's have been rolled out at St. Louis and at this writing no reports of engine failure had been received.

Remmert-Werner is guaranteeing in excess of 200 mph at 9,000 ft. My notes, compiled as pilot of a Super -92 with Bill Remmert sweating it out as my copilot, show that at 9500 ft the DC-3 indicated 170 mph at 30.5 inches and 2100 rpm. It trued out at 201 mph at this setting, which provided about 680 hp.

The Super -92's single-engine performance appeared to be highly satisfactory. It held its altitude comfortably at 9500 ft, showing little loss as it leveled out to 125 mph.

The pilot's compartment of the Super -92 adheres to the SAE configuration. The sliding seats can be raised or lowered. Immediately back of the pilot is the modern galley and in the space behind the copilot's seat is the compact radio junction panel.

The interior design of this executive DC-3 is one of the best I have seen. Beautifully styled as to color combinations and fabric, the passenger cabin includes facing davenports up front, swiveling chairs in the center section and a conference table at the rear. The surface of the conference table is an aeronautical map of the United States set in Formica. A dictating machine and a tape recorder also had been installed.

Another attractive feature of the Super -92 are the picture windows—two on the left side and one on the right. Each is five feet long and 15 inches deep. All windows are aerodynamically flush.

Remmert-Werner supplies with the Super -92, at no additional cost, a baggage compartment box containing the following items: complete tool kit for any type of emergency field work on engines or airframe; a complete set of seals, gaskets, packages and hoses for engines and accessory mountings; spare hydraulic pump, tail wheel shear pin, extra spark plugs, tach generator, starter, vacuum pump, generator, fuel pump and prop governor, and a kit of cleaning materials for the interior which includes a 24-volt vacuum cleaner.

There are 14 oxygen outlets in the passenger cabin, plus cockpit oxygen.

Remmert-Werner bases its designs on the fact that the average business trip is 596 miles—an easy three-hour flight in a 200-mph plane and an easy same-day round trip. The company occasionally handles the conversion of higher speed planes, but Bill Remmert reports that few executives are willing to pay for a possible extra 25% in cruising speed when it means

(*Continued on page* 52)

FIGURE 1
PROFILE OF BLOWING AIRFOIL

Boundary Layer Control

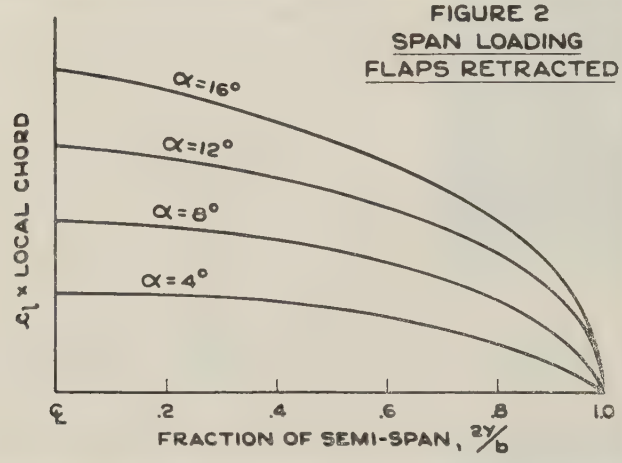
by Kenneth Razak
Dean, School of Engineering
University of Wichita

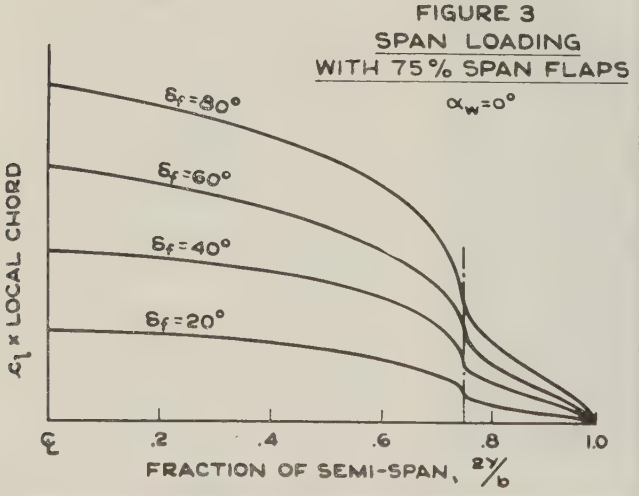
The increasing wing loadings of modern commercial and military aircraft has stimulated extensive research programs in the field of boundary-layer control for the purpose of improving flap effectiveness. A more effective flap system produces a higher wing lift coefficient, reduces the take-off, climb, and landing speeds and, therefore, reduces the landing and take-off distances.

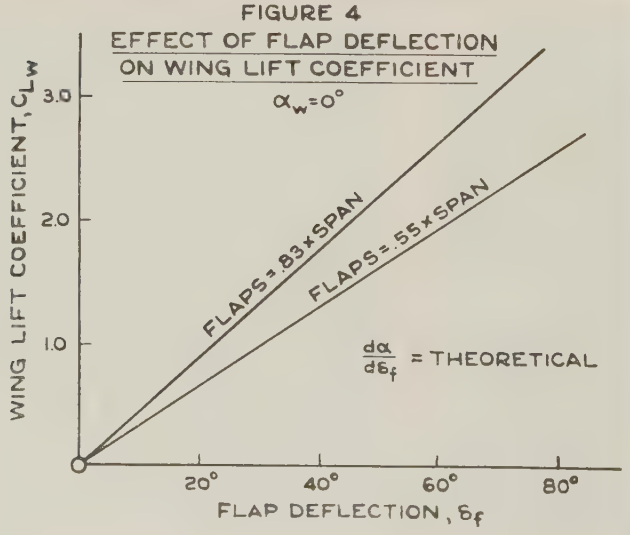
The major obstacle standing in the way of adopting a system of boundary-layer control has been the lack of detailed information that the designer can use to accurately predict the airplane performance, select the variables required for a specific design, and identify the procedures that he must follow to assure a successful application. Recent research, particularly that sponsored by the Office of Naval Research, has provided the necessary data to make an application of blowing boundary-layer control to trailing-edge flaps. The purpose of this article is to describe the benefits which can be secured from the use of boundary-layer control and to outline the general procedures of application.

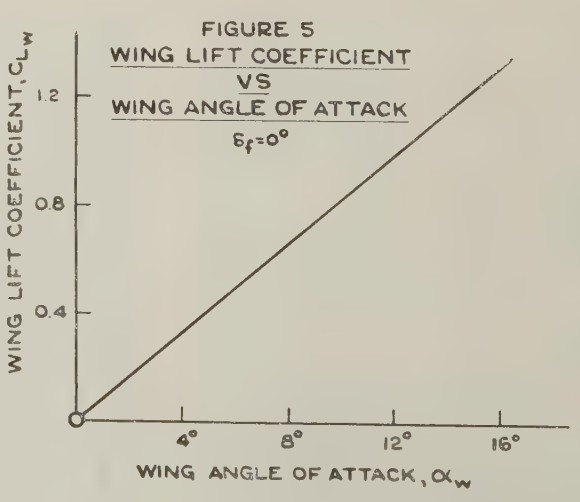
While we will not deal with the many different methods and purposes of boundary-layer control, some identification of the different forms of boundary-layer control is necessary to permit the uninitiated to appreciate the particular application discussed here.

Basically, the boundary layer is that film of air immediately adjacent to a surface which is retarded by viscous forces and is, therefore, moving at a velocity less than that









of the free stream. Both direct and indirect actions occur as a result of the boundary layer formation. The direct action is the dissipation of energy by the viscous shear which produces the skin friction drag on the aircraft. The indirect action is the flow reversal in the boundary layer, as a result of decreased kinetic energy, which can produce turbulent separation, wing stall, and various secondary flow patterns.

One scheme of boundary-layer control maintains laminar flow over the wing surface and prevents the development of a turbulent boundary layer that dissipates large amounts of energy. This type of boundary-layer control requires the use of perforated, porous, or slotted surfaces, and is particularly important for those aircraft flying at very high speeds at low lift coefficients. The benefits derived from a successful system of this type are great but it is one of the most difficult problems which the aerodynamicist has yet tackled.

Other schemes of boundary-layer control prevent or delay the development of turbulent flow separation on deflected flaps or on bluff bodies such as fuselages, struts, or fillets. No particular attention is paid to the character of the boundary layer itself, *i.e.*, whether it is laminar or turbulent. Primary attention is paid to the prevention of adverse pressure gradients, the removal of low-energy boundary layers by suction, or the stimulation of the boundary layer by the injection of high-energy air near the point of pressure gradient reversal.

This article concerns the type of boundary-layer control achieved by ejecting high-energy air from a narrow slot above and ahead of a single-slotted flap for the purpose of preventing turbulent-flow separation on the upper surface of the flap and again establishing a stagnation point at the flap trailing edge.

Aerodynamic Benefits

A direct result of BLC is the improvement of the maximum lift coefficient that can be developed with a conventional wing. For wings with flap spans of about 75%, maximum trimmed lift coefficients of about 3.3 to 3.5 can be secured, with thrusting power off. Values of lift coefficient with power on will increase to 4.5 to 5.0. These lift coefficients can be attained with wing lift/drag ratios ranging from 5.0 at the highest lift coefficient of 8.0 to values of 8.0 at lift coefficients of 3.2. These lift/drag ratios are cited to illustrate the useability of such lift coefficients, since they will give good climb performance.

Because flight speed varies as the square root of the lift coefficient, the above lift coefficient values make it possible to take off, climb, and land at speeds about 25% below present practice. The landing and take-off distances vary almost directly as the lift coefficient and will, therefore, decrease from 40% to 50%. Sufficient flight testing of aircraft with boundary-layer control has been performed to indicate that, with proper design, no stability or control problems will be encountered in utilizing these lift coefficients. (*Continued on page* 36)

FIGURE 9
EFFECT OF PROPELLER DESIGN ON PERFORMANCE

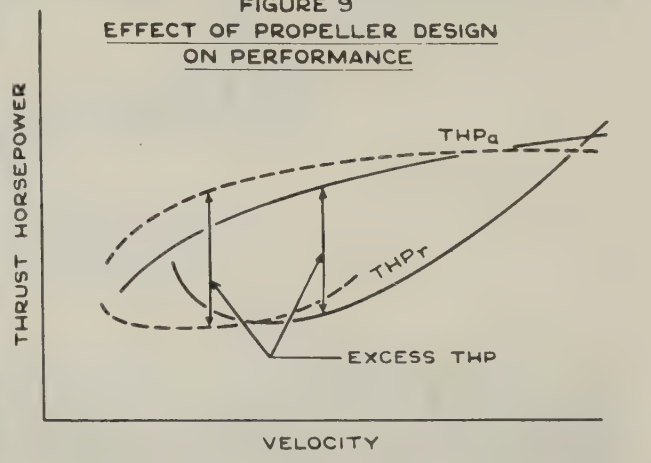
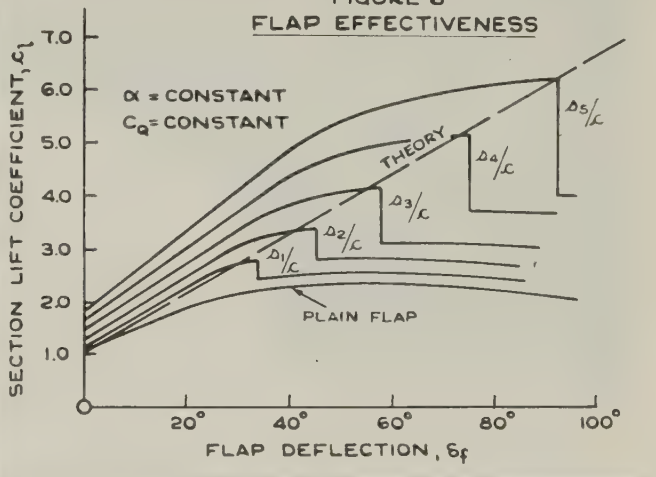


FIGURE 8
FLAP EFFECTIVENESS



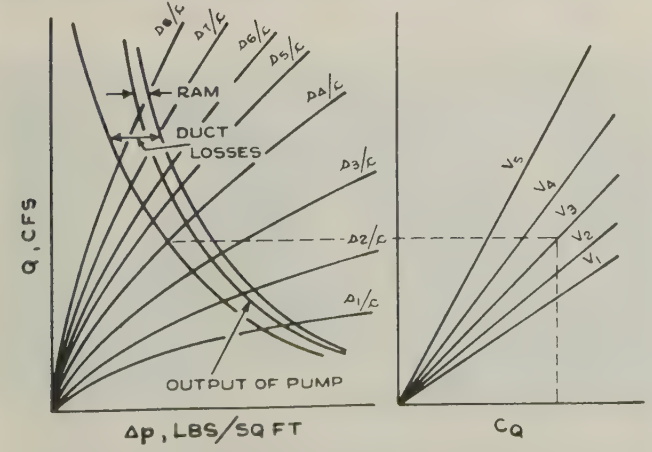
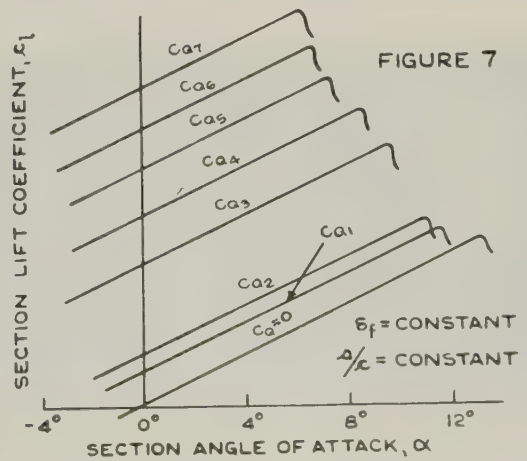


FIGURE 6 - BOUNDARY LAYER DESIGN CHART

FIGURE 7



SKYWAYS
FLIGHT OPERATIONS
ROUND TABLE

DECEMBER 1954 *Wings Club, New York*

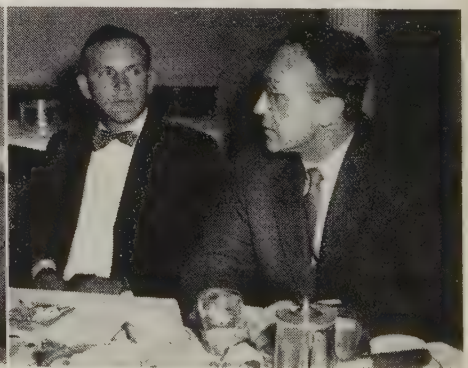
Problems in Braking Military and Civil Aircraft

Continuing development of deceleration devices will provide more efficiency in military and greater safety in civil operation of high-performance transports

ROUND TABLE *on the subject of braking military and civil aircraft was attended by (left to right around the table) Steve Scott of Hydro-Aire, Inc., who served as an observer, and the participants Leo A. Geyer of Grumman Aircraft, R. C. McGuire of Eastern Air Lines, Orville L. Wilkinson of Hydro-Aire, Inc., Monte H. Snedeker of Aircraft Engineering Foundation, Herbert O. Fisher of Port of New York Authority, Tom Sullivan also of Port of New York Authority, Thomas E. Cooper of Northwest Airlines, Robert L. Nordli of Wright Air Development Center, and Harold Hoekstra of CAA who served as the discussion's moderator*

"ANTI-SKID *system," reported Tom Cooper (right, next to Tom Sullivan), "makes possible a 15% increase in tire life"*

"PROP REVERSING *brings up problem of damage to props from material kicked up off runway," said Harold Hoekstra*



"USE *of chute to brake jet transport," reported R. C. McGuire, "probably will not be acceptable to commercial operators"*

Moderator Harold Hoekstra *(Chief Project Officer, Aircraft Engineering Div., CAA):* "Gentlemen, today's subject concerns the problems in braking high-performance military and civil aircraft, particularly transports. In our preliminary discussion it was generally agreed that we divide this topic into four main areas: 1) brakes as we know them now; 2) the use of the powerplant for braking, *i.e.* propeller reversing, use of reverse jet thrust, etc.; 3) aerodynamic means of braking, *i.e.* flaps, spoilers, parachutes, boundary layer control and other high-lift devices; and 4) ground equipment for braking, including arresting gear, nets, etc.

"Tom Cooper of Northwest Airlines, would you lead off the discussion for us?"

Brakes & Anti-Skid Devices

T. E. Cooper *(Supt., Aircraft Engineering, Northwest Airlines):* "Perhaps I'd better summarize our background with the Hytrol anti-skid system we installed on our 10 B-377 aircraft in 1952. Prior to equipping these aircraft, we had service tested one installation on a Boeing B-377 for one year, and at the end of that period we decided to install the equipment on the remaining nine aircraft. Unfortunately, I can't give you a lot of figures on the decrease in tire wear, etc., we experienced following the fleet installation of the anti-skid system. The only figures I have apply to just that one airplane on which the tests were made. During that one-year period, we had about 18 tire blowouts on the nine aircraft that did not have the anti-skid equipment; in addition, about 27 tires were removed because of flat-spotted areas. The airplane that had the anti-skid equipment installed did not experience any blowouts or flat-spots. As far as the wear on tires is concerned, the figures we obtained indicated we could expect a 15% increase in tire life if we used anti-skid equipment.

"We are entirely satisfied with the Hytrol equipment and we have not, to my knowledge, had any tire blowouts since it was installed. The pilots are happy with the equipment and they feel that it does give them added safety protection, particularly on some of our routes where crosswind landings are frequent. Braking becomes very important under crosswind conditions, and with the anti-skid system the pilot can just about forget about the possibility of tire blowouts.

"We do have a few problems concerning maintenance of the equipment. I wouldn't say it was anything unusual, however, when compared to other systems that use equivalent relays and electrical devices.

"As far as the other aircraft in our fleet are concerned, we would like to install the Hytrol anti-skid system on our DC-6B's and also on the 1049G's that we have coming up. Unfortunately, present conditions do not warrant it right now.

"I would certainly recommend anti-skid equipment on large aircraft. It offers definite advantages from both a safety and an economic standpoint."

Harold Hoekstra: *"Bob McGuire of Eastern Air Lines has had extensive airline experience, and I'd like to have him give us his thoughts on this general problem of braking."*

R. C. McGuire *(Asst. to Vice Pres.-Engr., Eastern Air Lines):* "I think the anti-skid system does a wonderful job but from the point of tire savings, I question whether it is as economical as it appears to be. The primary advantage of the anti-skid system is one of safety. I believe Mr. Cooper said that an airplane using reverse propellers still requires some kind of anti-skid equipment in a strong crosswind. Presumably, the reverse-thrust propeller system is used to slow down the airplane, and the anti-skid is used to aid steering control. Is this correct?"

T. E. Cooper: "Different conditions are involved there. We have found that there are times when we cannot or do not want to use the propeller-reversing system to its greatest extent because of runway conditions. For example, we go into certain fields that oftentimes have a little gravel on the runway. Under such conditions we tell the pilots to go easy on the prop-reversing system because the gravel can do excessive damage to the propellers—the prop blades on a Boeing are pretty expensive. As a result, the pilots depend more on the braking system."

R. C. McGuire: "That is a good example of how anti-skid and reverse thrust are used for specific conditions. Under such conditions, all airplanes could be equipped, justifiably, with an anti-skid mechanism and also incorporate some kind of aerodynamic reverse-thrust. All of these things—aerodynamic braking, automatic skid control, and good brakes —will probably be on all future air transports."

Harold Hoekstra: *"Orville Wilkinson, you've had a good look at the anti-skid picture. Have you any points you'd like to bring out?"*

Orville L. Wilkinson *(Mgr., Hytrol Div., Hydro-Aire, Inc.):* "For the benefit of those who are not familiar with anti-skid braking systems,

ROUND TABLE PARTICIPANTS

HAROLD D. HOEKSTRA, Chief Project Officer, Aircraft Engineering Div., has been with the CAA since 1937; is graduate engineer, holds a commercial pilot rating.

R. C. McGUIRE, Ass't to Vice President-Engineering, EAL, is a graduate mechanical engineer, NYU. Before joining Eastern, he was with United and then American Airlines.

LEO A. GEYER, a graduate of U. of Rochester and Ga. Tech, joined Grumman as an aerodynamicist. At the present time he is working on boundary layer control.

MONTE H. SNEDEKER, president of Aircraft Engineering Foundation, has been active in field of aircraft manufacturing and the airlines for more than 25 years.

T. E. COOPER is superintendent of aircraft engineering for Northwest Airlines. He is graduate of U. of Minnesota (1936) and spent two years in the Navy.

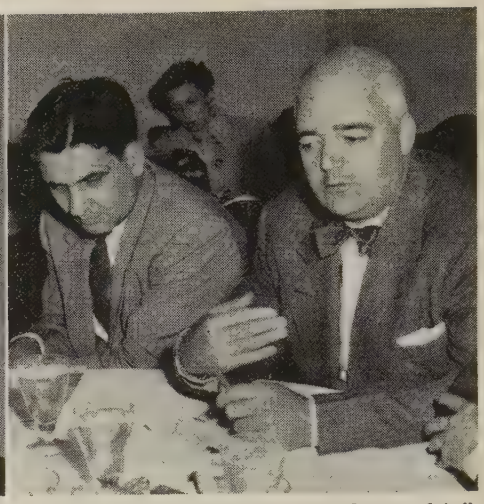
THOMAS M. SULLIVAN, Chief of Planning for Port of New York Authority, is a graduate of the U. of Oklahoma. He began his aviation career with TWA.

HERBERT O. FISHER, Chief of Aviation Development for the Port of New York Authority, spent 14 years as an engineering test pilot for Curtiss-Wright Corp.

ORVILLE L. WILKINSON is a graduate aeronautical engineer. He was the first engineer assigned by Hydro-Aire, Inc., in 1949 to its Anti-Skid System project.

ROBERT L. NORDLI, Ass't Chief, Engine Installations Section, WADC, has been employed by the Air Force since his graduation from Iowa State University in 1949.

"HYTROL *system of braking was designed as auxiliary to the regular braking system," explained Orv Wilkinson (left). "It enables the pilot to land safely with maximum braking"*



"PROP *reversing can extend tire life," said Herb Fisher, "if it's used properly"*

I'd like to describe very briefly Hydro-Aire's Hytrol system. This system is designed as an auxiliary to the regular braking system, enabling the pilot to land with maximum braking . . . and to do so safely. A skid sensing device in the wheel of the plane detects the incipient skid and causes a solenoid valve in the hydraulic brake line to release the brake momentarily. In this way Hytrol puts the stopping of an airplane on a scientific basis. Without such a system, the pilot must depend on intuition to tell him what the wheels are doing . . . and with increased speeds of new aircraft, that isn't good enough. Tom Cooper has already told you something of Hytrol's record on the Northwest *Stratocruiser* fleet. I might mention that Hytrol is also standard equipment on all B-47's, B-52's, and has recently become standard equipment on the Douglas A-3D. The system has been proven successful on more than 26 different types of aircraft—including Drones.

"Tom, I'd like to ask you if, in an emergency or an all-out stop effort, you don't find that the anti-skid also facilitates getting the reverse on at a higher speed where it is more effective? Don't you get braking quicker and more effectively through the use of anti-skid?"

T. E. Cooper: "There's no question but what an airplane can be stopped quicker if you can apply brakes during the initial phase of the landing and don't have to worry about blowing a tire. You can come in and have your brakes full on and the anti-skid equipment automatically will monitor the maximum braking effort you can obtain."

Harold Hoekstra: *"Monte Snedeker, would you like to add anything?"*

Monte H. Snedeker *(Pres., Aircraft Engineering Foundation):* "As you know, Aircraft Engineering Foundation is flying the anti-skid equipment for the first time on a tail-wheel airplane. We're still in the test stages, so perhaps Mr. Cooper's experience would be of benefit to us.

"Mr. Cooper, in your application, did you attempt to reduce your accelerate-stop distance requirements with the CAA?"

T. E. Cooper: "When we obtained CAA certification of the anti-skid equipment on the B-377, it was not our intention to make any effort to obtain shorter landing distances or changes in the basic performance of the airplane as a result of the equipment. I do think, however, it could be obtained if an operator wants to spend the time, and needs the shorter runway distances."

M. H. Snedeker: "From our preliminary tests, I'd say our airplane is not particularly critical on accelerate-stop. Our trouble is that we have better accelerate-stop than we can use advantageously.

"The other thing I wanted to ask has to do with truck-type gear. We have had two or three accidents as the result of hard application of the brakes, particularly on take-off. A decision to abandon the take-off left the pilot with not enough braking to stop the airplane. Have you had any experience in your operation that would be of value to us in considering that problem?"

T. E. Cooper: "I don't recall that we have had any actual experience where we have had to rely on the anti-skid device to stop an airplane quickly on take-off."

M. H. Snedeker: "We had a CV-240 in which a take-off was abandoned at just about V_1. In the ensuing few seconds a very hard application of the brakes blew a tire on each side, and the remaining braking ability was such that the airplane ran out of the field at about 50 knots. We lost an airplane worth some $380,000. It would seem to me that the anti-skid equipment would be particularly applicable to that type of gear, from a safety standpoint as well as an economic one."

T. E. Cooper: "The day we ran the CAA-certification tests, the runway conditions were extremely poor. Although we had frost and some ice on the runway, our stopping distances with the anti-skid device were within 50 feet of that on a dry-runway condition."

Harold Hoekstra: *"That emphasizes the importance of the use of these devices in addition to brakes. There is no question but that the work being done by Hydro-Aire, Goodyear, Westinghouse, etc., is going to add to our progress in this area.*

"Looking at the problem of getting a coefficient of friction between the runway, the tire, then the tire into the wheel, and the wheel to the brake drum and shoe, is there any possibility of our going to some direct means of braking, such as putting a shoe directly down on the ground without going through any rotation?"

R. C. McGuire: "The French have a jet fighter that operates on skids, but I doubt whether this type of braking would be used on an American transport plane. I just can't visualize making a belly landing with a load of passengers!"

Harold Hoekstra: *"Bob, I hadn't intended to go quite that far.*

"Tom Sullivan, what would the Port of New York Authority's reaction be on this matter?"

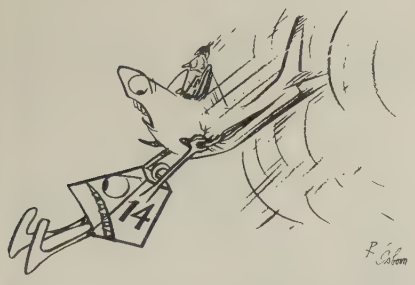
Tom Sullivan: *(Chief, Aviation Planning, Port of N.Y. Authority):* "We are concerned with the surface

(*Continued on page* 40)

Performance PITFALLS

from the Files of the Flight Safety Foundation

by Jerome Lederer and Robert Osborn



FOURTEEN G'S IN THE MOUNTAIN WAVE

Attention is directed to the following information about conditions encountered in the mountain wave. This originally appeared in the Flight Safety Foundation-issued excerpts from the publication "The Mountain Wave" by C. F. Jenkins of the Air Force Cambridge Research Center. It is worth repeating.

"Pilots who have the greatest experience in both soaring and flying under wave conditions relate that they consistently lost control completely for short periods while under the influence of the roll cloud. For example, a BT-13 flown under full power at 10,000 feet from the rotor zone toward the peaks will lose altitude even while attempting to climb. A pilot who took some cloud pictures soared a P-38 from 15,000 to 30,000 feet in the updraft area with the props feathered while he took his pictures.

"Pilots investigating the wave relate that they have experienced more hazardous flight conditions in the wave than they have encountered in any thunderstorms. In fact, effective gust velocities, measured in sailplanes at altitudes up to 39,000 feet, were of the order of 50 feet per second. In wave flight, full controls have to be used to maintain a heading.

"Calculations show that high-speed aircraft (jet-class) would experience accelerations of from 8 to 14 g's while flying downwind through the areas of varying vertical motions. Thus, the wave is structurally dangerous to these aircraft."

INJURIES RESULTING FROM TURBULENCE

The following letter is from a Vice President of Operations to his pilots.

"The increase in speed in modern aircraft has been accompanied by an increase in the number and severity of injuries, resulting from turbulence, to passengers and flight attendants. Some of these occur in clear air turbulence. Others occur in frontal or thunderstorm areas where turbulence is known to exist.

"In practically all cases of injuries, the passenger's seat belt was not fastened. Generally, this was because the sign was not on, or had not been on long enough for the attendants to check the belts. In several cases, there was a passenger in the lavatory who did not have time to return to his seat. In other cases, the passenger had unfastened his belt.

"Attendants were injured while checking seat belts, checking lavatory for passengers, or administering to sick passengers. In most instances the seat belt sign was on, but the 'No Smoking' sign was off.

"Six attendants were on the injured list for a total of 159 days last year. This emphasizes the need for taking all possible precautions against injuries caused by turbulence."

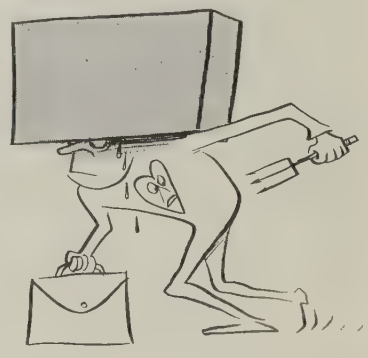
Recommended procedure:

1. Turn seat-belt sign on in time for passengers in lavatories to return to seats, and to permit attendants to check belts.
2. Attendants should check passengers' seat belts as quickly as possible after light comes on.
3. Keep seat-belt sign on while flying in areas of possible turbulence, even though no turbulence is being experienced.
4. Attendants should remain in seat as much as possible, even though the 'No Smoking' sign is off. Perform only necessary duties. Check with Captain on possibility of turbulence.

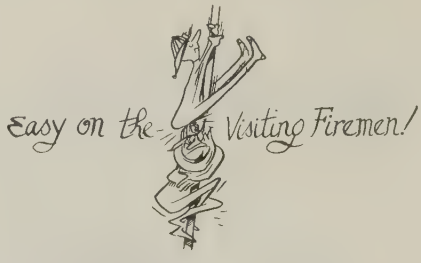
THE CORONARY CLUB

The following are membership requirements offered by a convalescent:

1. Your job comes first; personal considerations are secondary.
2. Go to the office evenings, Saturdays, Sundays and holidays.
3. Take the brief case home on the evenings when you do not go to the office. This provides an opportunity to review completely all the troubles and worries of the day.
4. Never say NO to a request—Always say YES.
5. Accept all invitations to meetings, banquets, committees, etc.
6. Do not eat a restful, relaxing meal—always plan a conference for the meal hour.
7. Fishing and hunting are a waste of time and money—you never bring back enough fish or game to justify the expense.
8. It is poor policy to take all the vacation time which is provided for you.
9. Golf, bowling, pool, billiards, cards, gardening, etc., are a waste of time.
10. Never delegate responsibility to others—carry the entire load at all times.



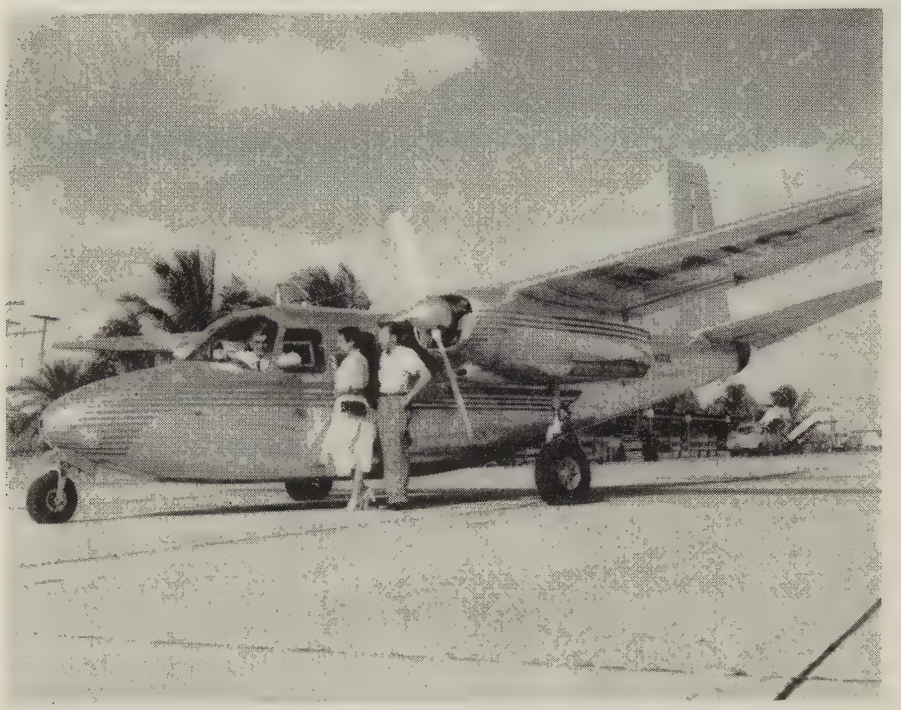
11. If your work calls for traveling—work all day and drive all night to make your appointment for the next morning.



RATE OF DESCENT

The CAA offers the following in order to insure standard vertical separation at all times between holding aircraft—and it bears repeating: "Unless otherwise advised by the controller, Air Traffic Control expects that aircraft will descend in holding patterns in accordance with standard procedure at the rate of 500 fpm. Upon receiving a report that an aircraft has vacated an altitude in descent, a clearance may be issued to the next aircraft above to descend to the lower altitude. Should the higher aircraft descend at a rate greater than the 500 fpm required for the aircraft below, less than the vertical separation of 1,000 feet could very easily result. Pilots desiring to descend at a rate in excess of 500 fpm should make this fact known to the controller and obtain his assurance that it will not result in conflict with other aircraft below. In some instances controllers might anticipate this desire and so advise a particular flight. Therefore, check with the controller at all times before descending at a greater or lesser rate than 500 fpm."

SKYWAYS FOR BUSINESS



NAT'L UNION LIFE INSURANCE CO. *Commander is used to speed executives on trips throughout the Southeast. Chief pilot is Capt. Harold A. Lanigan, shown here at controls*

Insurance Company Utilizes Aero Commander, Cessna for Business

Miami, Fla. An Aero *Commander*, one of the most completely equipped in service, and a Cessna 180 are speeding executives of the National Union Life Insurance Co. on company business throughout the Southeast. One trip alone, according to a report from Capt. Harold A. Lanigan who is in charge of the aircraft, produced over $250,000 in new business. In addition to piloting and supervising operation of the planes, Capt. Lanigan also is an agent of the company.

The company's *Commander* is equipped with a Lear autopilot with approach coupler, visual oral range, dual ADF's, ILS, dual VHF transmitters and receivers, and an HF transmitter and receiver, plus instruments for all-weather flying. Based at Miami International Airport, the Aero *Commander* is used throughout Florida and Alabama, and several trips have been made to California. The Cessna 180 is based at Brown's Airport and is used on the company's shorter trips.

Capt. Lanigan is an ex-Air Force pilot and following his discharge from the service, he flew scheduled airline operations in this country, Europe, Central and South America. Just prior to joining National Union early in 1954, Capt. Lanigan was with the CAA in Miami as a scheduled air carrier operations inspector.

Learstar Scheduled to Try Coast-To-Coast Speed Run

New York, N. Y. A non-stop speed run between Los Angeles and New York is being planned for the *Learstar*, a modified version of the *Loadstar* produced for the executive market by the Aircraft Division of Lear, Inc.

Sponsors of the transcontinental dash are confident that the *Learstar*, which set a new time record for this type of aircraft between Los Angeles and Dallas late in October, will better the time of twin-engine carrier equipment and come close to the best operational time of the DC-7 on the west-to-east run.

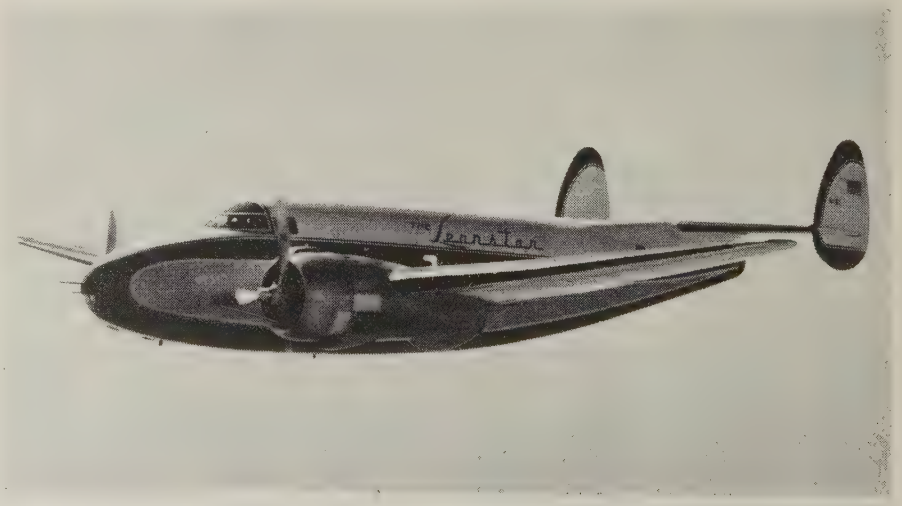
Hal Herman, Lear's chief pilot, flew the *Learstar* from Los Angeles to Dallas—a distance of 1310 miles—in 4 hrs and 16 minutes during the NBAA's annual meeting. The flight was made at 15,000 ft at 55% of rated power and an average speed of 296 mph.

With Fred Lee, CAA Administrator, and Jim Walker of *SKYWAYS* aboard and Bill Lear as host, the *Learstar* completed a flight between Dallas and Washington, D.C., in 3 hrs and 58 minutes. At 13,000 ft, 28 inches and 2100 rpm, the *Learstar* indicated 230 and trued out at 288 mph. Mr. Lee served as copilot for part of the trip, with Wiley Wright, executive secretary of the CAA's aviation development advisory committee, and A. B. McMullen, executive secretary of NASAO, as interested spectators.

Bill Lear, who came east to demonstrate the *Learstar*, reported that the transcontinental dash probably will be made above 20,000 ft and close to 70% of power. Herman, who piled up more than 12,000 hrs with Naval air transport, probably will be the pilot.

Executive Heron Being Shown To Corporate Aircraft Owners

Washington, D.C. An executive version of the de Havilland *Heron*, primarily intended as a personal vehicle for His Excellency the British Ambassador to the U.S.,



LEARSTAR *is expected to better the time of twin-engine airline equipment and near operational time of the DC-7 on its non-stop speed run from Los Angeles to New York*

Sir Roger Makins, has been on a demonstration tour of the East Coast and was shown to members of the National Business Aircraft Association at their Annual Meeting in Dallas, Texas, in October. Equipped to carry eight passengers in a high standard of comfort, the Executive *Heron* has an all-up weight of 13,000 pounds, and can carry its full complement of passengers, with 44 pounds of baggage each, over stage-lengths up to 850 miles. This allows the extra fuel reserves that are necessary under IFR conditions. Under VFR conditions, the *Heron* has a range of 1100 miles. Powered by four de Havilland *Gipsy Queen* engines of 250 hp each, the Executive *Heron* (with retractable undercarriage) cruises at 183 mph.

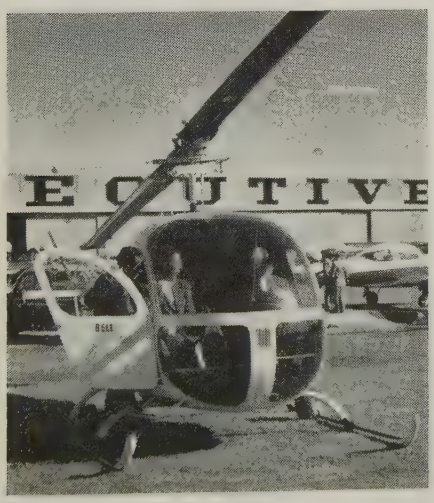
Cornell-Dubilier Electric Installs RDR in its DC-3

St. Louis, Mo. The first commercial installation of the new Bendix RDR-1 Airborne Radar System for business aircraft is now being made in a DC-3 owned and operated by Cornell-Dubilier Electric Corporation, of South Plainfield, N.J. The RDR System will allow the pilot to avoid thunderstorms, turbulence, and other undesirable weather conditions, thereby increasing safety and comfort of the flight, reducing the possibility of structural damage to the aircraft, and permitting a closer adherence to flight schedules.

The installation is being done by Remmert-Werner, Inc., which also made the demonstration RDR installation in the Bendix DC-3.

Flying Medics Plan New National Organization

Tulsa, Okla. A national organization of aviation-minded physicians is being formed, and plans are underway for a selection of officers, adoption of a name, drafting of by-laws, etc., at the next meeting of the American College of Surgeons. Flying physicians may get further information from Mark E. DeGroff, PO Box 3275-C, Tulsa 12, Okla.



EXECUTIVE *Bell copter was shown to NBAA members attending convention in Dallas*

. . . . in the business hangar

Paul Smith Construction Company's Twin Beech, of Nassau, Bahamas, has been at Aerodex in Miami for minor repairs.

Bob Harlow of Transcontinental Gas Pipeline Corp. has his company's PV-1 at Qualitron in Burbank for extensive rework. Qualitron is fabricating and installing custom-built, edge-lighted remote control radio panels.

International Harvester has had a Collins Integrated Flight System installed in one of its DC-3's. Work was done at Remmert-Werner in St. Louis. A new set of Goodrich de-icers also was installed. Chief pilot for IH is Bill Dotter; G. J. Eger is International's NBAA representative.

Bob Mays recently brought Thomason Plywood Company's D18 to Piedmont Aviation, Inc., Winston-Salem, N.C., for an engine change and other aircraft work.

Fairchild Engine and Airplane's *Lodestar* has been at AiResearch Aviation Service for installation of nylon fuel cells to replace the integral tanks.

Curly Korb, Chief Pilot for Westinghouse Electric, has his company's DC-3 at Page Airways, Rochester, for installation of a Sperry A-12 autopilot and a Bendix DME. Korb is also WE's NBAA rep.

Sears, Roebuck & Company's Atlanta Division DC-3 is back in operation after installation of new engines at Executive Aircraft Service, Dallas. Sears' pilot is Bill Dameron. NBAA representative is J. V. Swanson, chief pilot and boss of Sears' whole aircraft operation.

S. Morgan Smith Co. has had its *Lodestar* at Mallard Industries, Stratford, Conn., for 100-hour relicense and installation of a dual fuel system. Ed Lubischer, boss of the company's Air Transport Dept., brought the plane in and stayed with it until the work was completed.

The Philadelphia *Evening Bulletin's Lodestar* sports a new paint job done by Reading Aviation Service, Inc., Extensive gas tank work also was accomplished by Reading.

Grumman Aircraft is adding a second Super-92 DC-3 to its fleet of aircraft. Like its first Super-92, this one has a Sperry A-12 autopilot, Collins radio, dual RMI.

Bendix Products Division's B-25 flying laboratory has been at Pacific Airmotive for modification of the spar cap and a complete paint job. Bendix pilots, Homer Stockert and Howard Williams, brought the ship in from its home base at South Bend, Indiana.

Blythe Brothers Construction Company has its Twin Beech flying again after general maintenance work at Aerodex, Miami.

A Flite-Tronics CA-1 audio amplifier has been added to the Model 50 Beechcraft owned by Victor y Mauricio De La Lama of Mexico. Installation was made by Aircraftsmen, Inc., Oklahoma City.

M. E. Tarbert brought Pure Oil's DC-3 to Southwest Airmotive, Dallas, for carburetor and generator replacements and a check of the autopilot. Home base for the DC-3 is Chicago.

Richfield Oil Corp. has added another Twin Beech to its executive aircraft fleet, and Chief Pilot Joe Brown has been in the process of standardizing the radio equipment used in the ships. Major changes being made in the radio systems include complete rewiring of the radio electrical systems, new master radio junction boxes, relay panels and custom-built, edge-lighted remote control radio panels, Bendix VHF communications system and dual ARC omni systems. Qualitron, Burbank, is doing the re-working.

Bob Ward brought Baggett Transportation Company's Twin Beech to Remmert-Werner for new interior, a complete exterior paint job, recovering of all surfaces with Monsanto Skylac, and a relicense.

Chief Pilot Karl Styne has had Noland Company's D18 at Piedmont Aviation for 100 hour check and double engine change. Karl also is Noland's NBAA representative.

Dresser Industries and Fairbanks-Morse Company have had their PV-1's at AiResearch for miscellaneous repair work.

Official NBAA Report

NATIONAL BUSINESS AIRCRAFT ASSOCIATION, INC.

(formerly Corporation Aircraft Owners Association)

National Business Aircraft Association, Inc. is a non-profit organization designed to promote the aviation interests of the member firms, to protect those interests from discriminating legislation by Federal, State or Municipal agencies, to enable business aircraft owners to be represented as a united front in all matters where organized action is necessary to bring about improvements in aircraft equipment and service, and to further the cause of safety and economy of operation. NBAA National Headquarters are located at 1701 K Street, N. W. Suite 204, Washington 6, D.C. Phone: National 8-0804.

Pres. Eisenhower Commends NBAA for Role in Aviation

Dallas, Texas — Business aircraft operators are playing a significant role in the nation's economy and contributing to the steady advancement in aeronautical techniques and equipment, President Eisenhower said in a congratulatory message to more than 400 members of the National Business Aircraft Association assembled here for their 7th annual meeting and forum.

The President's letter, addressed to retiring NBAA chairman Cole H. Morrow and read at the annual dinner by his successor, Henry W. Boggess, follows:

"In our expanding American economy, business aircraft are playing a most significant part. Because of continuing advances in aeronautical techniques and equipment, future years should see them become even more important to our nation's business. To each of you attending the 7th annual meeting, I send my congratulations on your contribution to this development, which reflects the great power of our system of free private enterprise. You have my best wishes for success in your efforts in the years ahead."

The reading of the letter, which constituted first public recognition by the White House of the importance of business aircraft operations to the aviation industry, was greeted by thunderous applause and the same reception was given a telegram from Ned H. Dearborn, president of the National Safety Council, commending NBAA for its excellent safety record.

Meeting Sets New Records

The dinner in the ballroom of the Hotel Adolphus, at which Seaborn P. Collins, national commander of the American Legion, was principal speaker, was the final event of a three-day meeting which set several new records in addition to the new high attendance mark.

Love Field at Dallas recorded on Oct. 27, 28 and 29 the greatest one-airport concentration of business aircraft ever assembled. Approximately 75 aircraft, representing just about every type now being used by business and industry, were parked on the ramps around the busy field.

The attendance was 425, a new record, and it included more top officials of business aircraft user companies than any previous NBAA annual meeting. The number of such officials registered was 148 and, with few exceptions, every company manufacturing business aircraft was represented in Dallas by its president.

The meeting was noteworthy, too, for the unusually large number of federal, state and municipal officials present and for the large turn-out of representatives from the several large aviation associations, such as NASAO, NATA, and the Airport Operators' Council. The Civil Aeronautics Administration was represented at the annual dinner by its top official, Administrator Fred B. Lee.

Quotable Quotations

Seaborn P. Collins, national commander of the American Legion, who was elected honorary member No. 1 of NBAA, was principal speaker at the annual dinner. He said, in part:

"Impressive as the growth of commercial air transport has been, the past several years have seen it overshadowed by the introduction of the airplane as an indispensable tool of large and small business concerns. Last year America's business plane fleet logged about 6,450,000 hours in the air, covering in the neighborhood of 900 million miles. This compares with 525 million miles flown by America's scheduled airlines. Perhaps more surprising is the fact that the multi-engine aircraft registered in the 'businessman's air force,' outnumber the airline fleet by nearly two to one—2,437 multi-engine business aircraft compared to 1,269 operated by schedule airlines.

"One reason for the phenomenal growth in the ownership of business aircraft is the tremendous flexibility of operations provided to the private aircraft owner. Of the approximately 6,000 airports in the U. S., only about 600 are served by airlines. The executive found that decentralization and the pace of business competition literally forced him to use a transportation medium that would take him directly to his destination safely and rapidly. His solution to the problem has brought us all together.

"The constantly growing use of the business airplane has proven to be an economical, practical, efficient, and essential way of doing business. In no other way can the amazing growth of this fleet —up more than 300% since 1946—be explained.

"The NBAA can also justly feel proud of its services to our country. Many Americans recall with gratitude the community services you have so generously rendered in the past. Your sense of responsibility to your community and nation has been demonstrated time and time again when disasters such as floods and forest fires threatened the welfare of our people. The current educational effort of the NBAA in the critical area of adequate Civil Defense will prove invaluable should we ever face a national emergency of this nature."

Robert Ramspeck, vice president of Eastern Airlines and former member of Congress from Georgia, made a strong plea for closer cooperation between NBAA and the air carriers. Speaking at the annual awards luncheon, he said, in part:

"Business-aircraft operations are promoting air transportation. Many of the companies here today are big users of the airlines, in addition to trips made in their own aircraft. Airplanes are saving the valuable time of high-priced personnel in these days of keen business competition, but the company which does not own aircraft or does not use airlines is falling behind. One of the reasons for the growth of business-aircraft operations is that companies with their own aircraft are forcing their competitors to use the air.

"It is pretty well known that the size of the aviation industry could not be maintained today by the air carriers alone. As more and more companies buy and use aircraft, we shall have a more stable manufacturing industry and will, therefore, depend less and less on military orders to keep us healthy.

"The NBAA and the airlines should join hands to solve their mutual problems, which include airport development, taxation and airways user charges, to name only a few. Our mutual interests dictate closer cooperation for a common front whenever problems affecting either or both of us arise and demand clear-cut solutions."

Special Citations Awarded

Another highlight of the annual dinner was the presentation by Mr. Boggess of special citations to four aircraft manufacturers and one manufacturer of navigation, electronic and radio equipment.

The citations read: *"In recognition of your initiative, exemplifying true free enterprise, in the development and production of modern multi-engine aircraft designed primarily to meet the requirements of business flight operations."*

Recipients were: R. T. Amis, Jr., president, Aero Design & Engineering Co.; Mrs. Olive Beech, president of Beech Aircraft Corp. (accepted for her by Leddy Greever, sales manager); Dwane Wallace, president, Cessna Aircraft Co.; William T. Piper, Sr., president, Piper Aircraft Corp.; and William P. Lear, president, Lear, Inc.

The NBAA special award for 1954 was presented to Donald M. Stuart, director

of the CAA's technical development and evaluation center at Indianapolis. A bronze plaque, engraved by Cole Morrow in his Racine, Wis., basement workshop, cited Mr. Stuart for outstanding and individual initiative and leadership in the development of air-navigation aids, lighting, airports, aeronautical charts, radio and electronic equipment, and air traffic control devices and procedures.

Safety Awards Presented

In the realm of safety, NBAA member-pilots compiled a remarkable record in the year preceding the Dallas annual meeting. Official records reveal that they traveled 93,079,063 accident-free and injury-free miles on missions for their companies.

In recognition of this achievement, NBAA presented safety awards to more than 40 companies who flew 500,000 or more accident-free miles in the past year.

Meritorious safety awards were earned by the following companies, each of which traveled 1,000,000 or more miles without accident:

Aircraft-Marine Products, Harrisburg, Pa.; Burlington Mills, Greensboro, N. C.; Corning Glass Works, Corning, N. Y.; Robert Dollar Co., San Francisco; Esso Shipping Co., New York; Great Lakes Carbon Corp., Stratford, Conn.; Gulf Oil Corp., Pittsburgh; Hercules Powder Co., Wilmington, Del.; International Harvester Co., Chicago and Mobile operations; Monsanto Chemical Co., St. Louis; Northern Natural Gas Co., Omaha, Neb.; Owens-Illinois Glass Co., Toledo, O.; Pan American World Airways, New York; Phillips Drilling Corp., San Antonio, Texas; Procter & Gamble Co., Cincinnati, O.; Reynolds Metal Co., Richmond, Va.; Sears, Roebuck & Co., Chicago; Service Pipe Line Co., Tulsa, Okla.; Southern Natural Gas Co., Birmingham, Ala.; and Triangle Conduit & Cable Co., New Brunswick, N. J.

Service Pipe Line Co. led the list with 4,724,555 consecutive accident-free miles. Monsanto Chemical Co. was second with 3,578,202 miles, and Burlington Mills was third with 2,844,000 miles.

Sixty-eight pilots representing 41 companies holding membership in NBAA received safety awards for flying 500,000 or more accident-free miles in the past year. The companies were:

Anchor Hocking Glass Corp., ARMCO Steel Corp., Burlington Mills Corp., Estate of S. B. Burnett, J. I. Case Co., Corning Glass Works, Robert Dollar Co., Esso Shipping Co., Falstaff Brewing Corp., Gardner Board and Carton Co., Holley Carburetor Co., International Harvester Co., Koppers Co., Malco Refineries, Mellon National Bank, Minneapolis *Star and Tribune* Co., Monsanto Chemical Co., Murray Corporation of America, Ohio Oil Co., Olin Mathieson Chemical Corp., Pan American World Airways, Pillsbury Mills, Plymouth Oil Co., H. C. Price Co., Procter & Gamble Co., Pulitzer Publishing Co., Reynolds Metals Co., Rowan Oil Co., Sawhill Tubular Products, Service Pipe Line Co., Sinclair Refining Co., Southern Natural Gas Co., Thatcher Glass Manufacturing Co., Thompson Products, Triangle Conduit & Cable Co., US Steel Corp., Universal Moulded Products Corp., Vincent & Welch, Westinghouse Electric Corp., Wolfe Industries, and Frank Wood Associates.

Forums Cover Many Subjects

Business sessions drew the largest attendances ever recorded by the NBAA, and many subjects of interest to members were discussed at forums during the second and final days of the annual meeting. The first forum was devoted to a discussion of NBAA aims, objectives, benefits, services and activities, with Jean H. DuBuque, executive director of NBAA, as moderator.

William Strong served as moderator of a panel on business aircraft safety, and David D. Thomas of the CAA's Office of Federal Airways, led a panel on communications and air traffic. Cole H. Morrow was moderator of the air navigation panel. Walter C. Pague conducted a panel on business aircraft operations during the final business session.

NEW NBAA CHAIRMAN *is H. W. Bogess*

New Alignment of Officers

NBAA launched its eighth year of service to its members with the following slate of officers:

Henry W. Boggess, Sinclair Refining Co., of Tulsa, chairman; Ralph E. Piper, Monsanto Chemical Co., St. Louis, vice chairman; Gerard J. Eger, International Harvester, Chicago, treasurer; William B. Belden, Republic Steel Corp.; Joseph B. Burns, Fuller Brush Co.; Walter C. Pague, ARMCO Steel Corp.; Delos W. Rentzel, Auto Transports, Inc.; E. T. Spetnagel, Wolfe Industries; and Cole H. Morrow, J. I. Case Co., were re-elected to the board of directors. Mr. DuBuque continues as executive director of the association.

New Business Aircraft Shown

Delegates to the Dallas meeting spent part of the final afternoon attending a "hangar flying session" at Love Field during which several new aircraft models were shown. Three new aircraft were given their first public showings — the De Havilland *Heron*, a four-engine, eight-passenger executive transport recently flown non-stop from Great Britain to Canada; the Mooney four-place Model 20; and the Myers four-placer. Also on display were the completely modified *Learstar*, a faster version of the *Lodestar;* the *Skyrama* version of the DC-3 by Grand Central Aircraft; an executive version of the Convair 340 used by Long & Parker of Dallas; and the 100th DC-3 conversion produced by Executive Aircraft Co. Latest models produced by Beech, Cessna, Riley, Camair, Piper, Bell and Hiller also were on display. Electronic, navigation and safety equipment were on display in the Hotel Adolphus.

NBAA-MEMBER AIRCRAFT *on Love Field during convention, numbered 75. Bell copters and buses transported members from airport to Adolphus Hotel, annual-meeting headquarters*

LEAR

ARCON®

"Marks the beginning of a new era of both utility and safety"

...says Leighton Collins

WHAT IS THE LEAR ARCON? Left to itself, the average plane wants to fly in a circle. With the Lear Arcon, your plane wants to fly *straight*—until *you* want it to turn, thus eliminating the deadly "graveyard spiral"—always a threat to the non-instrument pilot.

IS THE ARCON AN AUTOPILOT? No, but it is the *next best thing* to an autopilot, especially when you are under pressure to do something else, such as navigate, communicate, or just plain relax.

IS IT A SUBSTITUTE FOR AN INSTRUMENT RATING? No more than a life-preserver is a substitute for knowing how to swim. However, the Arcon could save your life if you were inadvertently caught in "weather," and it will ease the burden of the qualified instrument pilot who *deliberately chooses* to fly instruments.

WHY IS IT THE FINEST DEVICE OF ITS KIND? The Arcon is simple, fool-proof, uncompromising in quality. Magnetic amplifiers are used instead of tubes—"printed" circuits instead of wires. No trim lights to monitor. Built to military standards of performance and dependability. Designed for trouble-free operation.

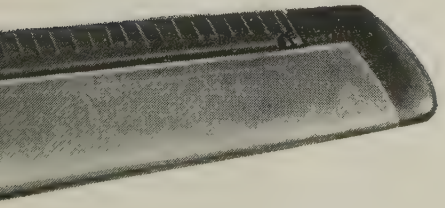
WHAT TYPE OF PLANE IS IT SUITABLE FOR? All types. And equally easy to install in all.

IS IT CAA APPROVED? Every Arcon installation is CAA approved for each airplane type.

IS IT INDUSTRY APPROVED? The Arcon will soon be offered as *factory* installed equipment by most leading aircraft manufacturers.

IS IT PILOT APPROVED? Ask any pilot who has had an opportunity to fly it. You will soon find very few pilots who will fly without it, because it makes an airplane fly the way it should fly—automatically. The Arcon is here *now*. See it. Fly it. Discover how it "marks a new era of safety and utility" for *you!*

See your nearest Lear distributor or write for full information to Lear Inc., LearCal Division 3171 S. Bundy Drive, Santa Monica, California.



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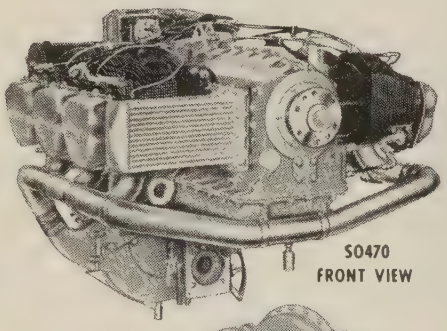
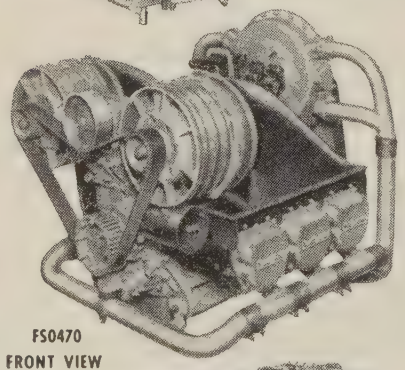
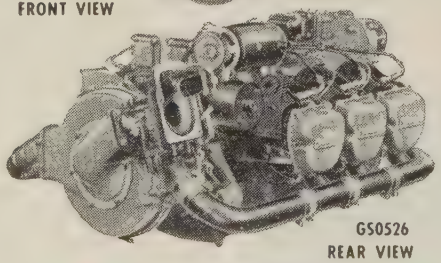
Here are three more reasons why tomorrow's finest aircraft, like today's, will fly with Continental power. Two of them represent further developments of the famous 0470 series —one supercharged, the other supercharged and fan-cooled expressly for helicopter use—while the third is a brand new power plant, engineered and built with the needs of multi-engine utility planes in mind. They have one thing in common: as products of the pioneer in power for utility aircraft, all three rate high in those qualities which go to make up dependability—qualities which have made Continental engines fliers' undisputed first choice.



S0470
FRONT VIEW



FS0470
FRONT VIEW



GS0526
REAR VIEW

GENERAL SPECIFICATIONS

	S0470	FS0470	GS0526
Horsepower	250	260	290
R.P.M.	2600	3000	3000
Alt. (ft.)	10,000	10,000	15,000
T.O. Power (Sea Level)	265	260	320
Length (in.)	37.73	39.64	52.28
Height (in.)	30.77	34.81	23.96
Width (in.)	33.62	33.62	34.68
Bore (in.)	5.00	5.00	5.125
Stroke (in.)	4.00	4.00	4.25
Displ. (cu. in.)	471	471	526
Comp. Ratio	6.0:1	6.0:1	6.0:1
Total Dry Wt. with Accessories (lbs.)	512	550	578
Type of Prop. Drive	Direct	Direct	Geared .688:1
Recom. Fuel Octane	91/96	91/96	91/96
Supercharger Ratio	12.45:1	10.13:1	12.0:1
Supercharger Drive	Belt	Belt	Gear

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Continental Motors Corporation
Aircraft Engine Division
MUSKEGON, MICHIGAN

Jet Transport

(*Continued from page 9*)

payload, which in turn affect the economy of operation.

Air Traffic Control: Traffic control should not require drastic changes in the present system except for the fact that it must be accelerated if full economic utilization of the turbojet is to be realized.

Of course, there is the fact that for long ranges the optimum cruise procedure for the jet is the constant true airspeed system which results in a continuous increase in altitude as fuel is consumed. For short ranges the optimum is climb to the greatest altitude for most economical fuel consumption followed by immediate descent if necessary. In dense traffic conditions such procedures present a problem. Of equal importance from a safety standpoint is the handling of the airplane in the vicinity of the airport, particularly during let-down procedures under conditions of low ceiling and poor visibility. It is here that ATC must streamline its operations.

The speed of the jet transport will necessitate quicker decisions on the part of the crew. The time for recognizing obstacles or other aircraft when they do become visible decreases rapidly with increased speeds. In order to enable the crew to make such decisions ATC personnel must maintain an accurate, uninterrupted and clear presentation so as to get the airplane on the ground in the shortest possible time. From an economic standpoint, once a descent has been started, the pilot is committed to land at that terminal. Present-day descent and holding procedures are, therefore, impractical for jet operations due to the fuel consumption involved, though this situation can be somewhat relieved by operating on one half the total number of engines.

Once the airplane is on the ground it is just as important from the standpoint of fuel consumption to get it to its ramp in the shortest possible time. Likewise, in the take-off procedure it is equally important to get the airplane away from the ramp and into the air as quickly as possible. This means keeping the runways and taxi strips free of congestion so that rapid taxiing and immediate take-offs are possible.

Navigation Aids: With higher speeds navigation must be accelerated. It seems quite likely that in addition to improved radio, landing systems and DME, search radar and possibly other collision warning systems will be required as a result of increased speeds, increased turning radius and decreased reaction time after visual discovery of another aircraft or obstacle.

Ground Handling

The matter of ground handling, particularly as it affects turn-around time, has been a sore subject in the past. It will be of even greater importance from the standpoint of the jet airplane. Because of its higher speed, the jet transport's revenue earning potential is greater than that of piston-engined aircraft. Thus, any delay in turn-around incurs a greater relative loss in revenue than exists with current types.

Quite obviously, the operator will want to utilize the speed advantage of the jet to its maximum in order to realize the greatest possible economic advantages.

(*Continued on page 32*)

New Radio Equipment for Smaller Business Aircraft

Because it is easy to forget that a number of corporation aircraft are not airline types, one tends to ignore the problems of the business man who flies his own airplane. Possibly one of the greatest of these problems is that of obtaining reliable, worthwhile radio equipment at reasonable cost.

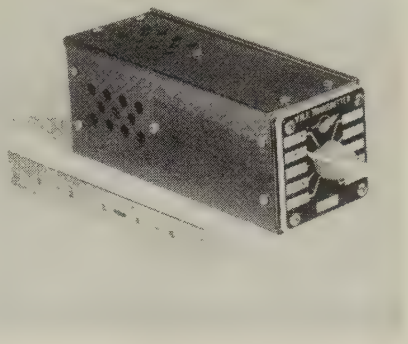
The larger professional-aircraft crews enjoy the advantages of riding the coat-tails of the airlines in that their equipment is designed for and service-tested in the highly accurate and rigorous field of the scheduled air-carrier industry. Before someone takes a pot-shot at your NAVICOM editor, let me concede that it is often the reverse, the corporation-aircraft crews being first to fully equip with VOR and DME! But generally speaking, the first statement is true.

On the other hand, the owner of the light personally flown business or private aircraft often must spend a disproportionate amount of money for an aircraft radio that frequently performs worse or less reliably than his car or bedroom radio. Not only does his life sometimes depend on such equipment but its malfunction in high-density terminal areas often brings down on the head of the unlucky pilot the wrath of hard-pressed ATC men and airport officials.

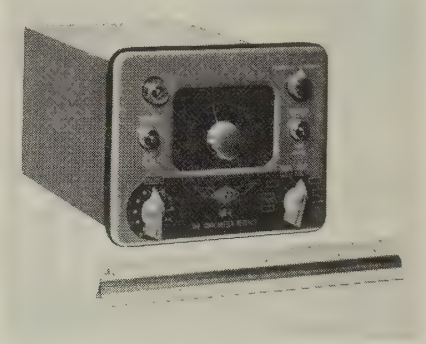
Therefore, it is always with hope that we see new firms entering the market and older ones improving, adding to and sometimes reducing the cost of proved equipment.

Typical of this is the announcement of Air Associates, Inc. that their AEROTRON, Model 200, 10-channel VHF transmitter is now available. Very suitable for original or replacement use, or as badly needed additional equipment, it lists at $79.50 and includes five crystals for "Emergency," "Ground Control," "Radio," "Tower," and "Unicom" operation (with provision for five additional channels). Antenna and installation kit sell for $10.50. The transmitter, which can be quickly installed in any standard 2¼" mounting, is powerful, compact and weighs only 8 ounces! Use of standard parts makes maintenance a simple and economical operation.

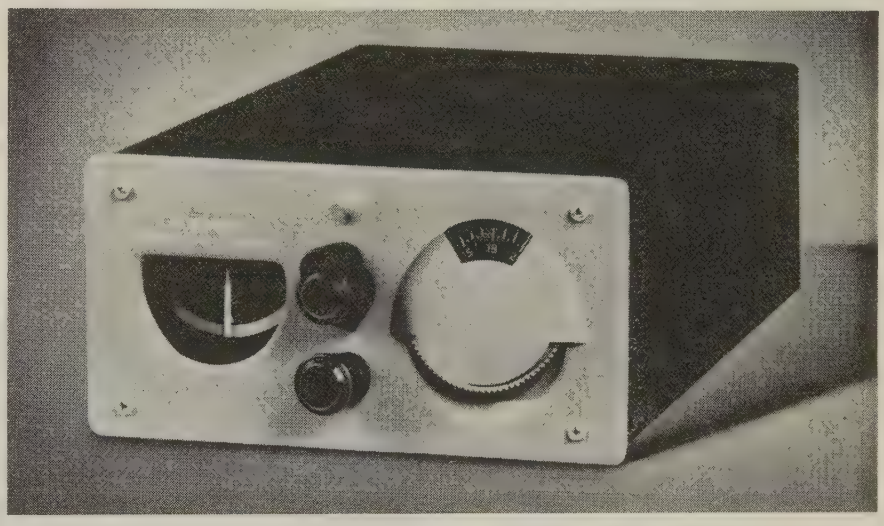
The transmitter is factory-tuned and tested and is immediately available at all Air Associates Inc. branches: Atlanta, Teterboro, Chicago, Glendale, Dallas and Miami.



AEROTRON *Model 200*



GONSET AR-1 *Transceiver*



NARCO *Omniplexer VOA-2*

Of equal interest is the introduction to the market of the AR-1 Transceiver by Gonset Co. of 801 S. Main St., Burbank, Calif. The AR-1 is extremely compact for a unit that comprises both transmitter and receiver. It will fit into the glove compartment of smaller aircraft and is very light in weight, only 4 lbs 7 oz, plus 3 lbs 4 oz for dynamotor power supply which operates on 12 to 14.5 volts D.C.

The receiver portion includes a superheterodyne receiver continuously tunable from 108 to 128 mcs, to provide coverage of all commonly used VHF navigational and ATC frequencies. Included circuitry permits the receiver to be used with Omni and other nav-aid equipment. Provision is also made for converters for the reception of LF.

Other pertinent features include fractional microvolt sensitivity, Gonset noise limiter, "push-to-calibrate" system which permits receiver to be set precisely to transmitter frequency without visual reference to dial calibration. (*Ed. note*—this feature now emerging in lower-priced VHF "tunable" receivers helps to lick the irritating problem of receiver-calibration drift and "head-down-and-locked" visual tuning so hazardous as well as irritating in the aforementioned high-density terminal areas!)

Dial is edgelighted with "*ON-OFF*" switch. Panel switch permits audio system to be used for intercom. Earphones or speaker may be used, and audio "sidetone" is provided.

Transmitter is an eight-channel crystal-controlled unit of 5.5 watts power input. (Crystals for 122.1 and 122.5 mcs only are supplied.) A panel indicator insures positive monitoring

(*Continued on page* 30)

Here Are Radio Facts You Should Know!

Shrug off the statements that matched brands and all-of-one make of radio equipment give better performance, increased efficiency, etc. As a simple, completely independent installation the MB-3 Marker Beacon Receiver doesn't know (or rely on) what other make of radio gear is aboard . . . it just goes on giving fine, dependable service . . . with accurate visual-aural simultaneous signal detection on three-light indicator and headset.

The many advanced features of the MB-3 are too numerous to list here but you should know that while other makes of marker receivers *may* offer comparable performance they all *weigh more and cost more* than the MB-3!

Navigate directionally with any radio . . . be sure you're there with a *Flite-Tronics MB-3 Marker Beacon Receiver!*

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of output and modulation. Price: Transmitter-receiver, $269.50. Complete auxiliary equipment, $30.00 (includes filtered dynamotor power supply, two VHF antennas, coax, connecting plugs and cables).

To complete the picture, NARCO, a leader in the VHF lightplane-radio field, announces a low-cost Omni converter to go with their SIMPLEXER, 12-channel VHF Transceiver. The new unit, called the Omni-Plexer VOA-2, can be mounted separately or on top of the VC-12 unit, and can be easily plugged into a receptacle already provided in the older unit. The unit resembles previous NARCO Omni equipment.

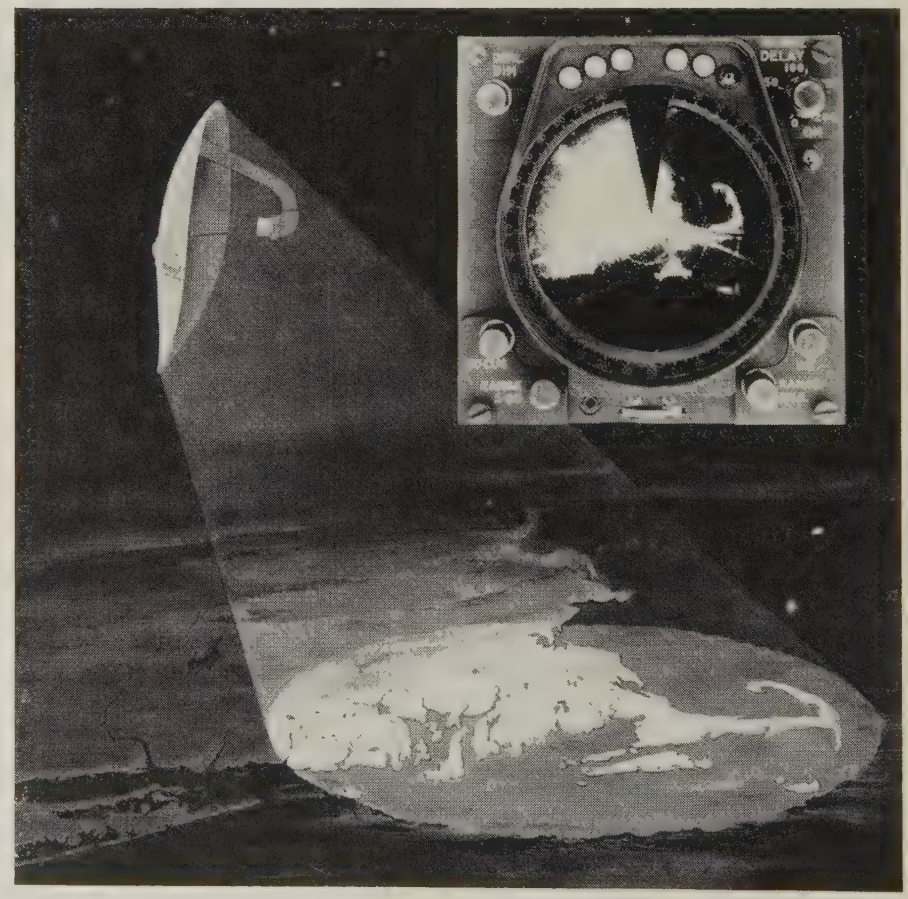
Sperry Enters Airborne Radar Market With APN-5

Ever since the challenge of developing a satisfactory airborne radar presented itself, Sperry Gyroscope Corp. has been in the airborne radar field. But the military prohibited any discussion of Sperry's keen interest and the development follow-through for which the company is noted.

The science of air navigation will never be anywhere near 100% complete until pilots can see their way anywhere at any time in any weather. Having previously contributed so much to navigational aids, the Sperry (and Air Force) announcement of the new APN-59 is not too much of a surprise. The unit weighs only 150 lbs., a low figure for first development announcement, has an 18-inch "turtle shell" antenna and a five-inch viewing screen.

Operationally, this unit is claimed to be the smallest and lightest for its range and power of any developed to date. The single unit features selectively the functions of search and surveillance, accurate navigation over uncharted airlanes, detection of distant storms and best-flying routes, anti-collision, etc. It can scan, again selectively, from 3 to 30 miles, or fixed ranges of wider areas at 50, 100 and 240 miles. Areas shown *may be oriented* to current heading of the aircraft, or optionally *to true North or any desired compass bearing.* Drift may be measured accurately by means of a rotatable dark plastic wedge superimposed over the scope. More than one indicator may be operated and, for larger planes, a 30-inch antenna is available.

Although Sperry cannot estimate the date of civilian availability, the very fact of its existence and excellence places a competitive pressure on the manufacturers of other airborne



SPERRY APN-59 *airborne radar reproduces what "turtle shell" antenna sees on the surface. The plastic wedge (atop scope) swings to any compass heading to measure drift*

radar already announced for the civilian market. Sperry's decision to remain with X-band (10,000 megacycles as against the C-band 5400 mc, as chosen by RCA and other large developers in the field already going into production) proposes an early service test of which is most practical for civil airborne navigation and storm penetration.

Unfortunately, military restrictions may prevent thoroughly adequate civilian comparison of the Sperry in airline or other civil use for some time, while RCA and Bendix with their units on United Airlines and Panagra respectively, will go far to settle the controversy (Bendix agrees with Sperry and is relying on X-band).

CAA to Operate AF Radar Approach Control Centers

In an extension of a policy that was developed within the last few years, the CAA announced recently that it had concluded an agreement with the Air Force to staff and operate 18 Radar Approach Control Centers (RAPCON) for the military at specified air bases.

For some time now, the military has turned to the CAA for assistance in training and developing the corps of traffic controllers, especially approach controllers. It would appear now that such efforts were not the most successful inasmuch as military personnel so trained were often needed elsewhere and not always in the ATC capacity, but usually in more military specialties.

The military necessity of mobility of personnel also precluded successful integration of military controllers handling a section of airway airspace over which CAA had the over-all jurisdiction and responsibility. A couple of years ago, CAA and the Air Force called on experienced CAA personnel from the surrounding region to staff an experimental RAPCON at MacDill AFB, Tampa, Fla. From this beginning, sprang the present program.

Normally, CAA controllers will staff and operate the Surveillance (Search) radar units for approach control of all traffic in the vicinity of a base, integrating that control with the CAA control of all traffic, to and from as well as en route, by the facility. The CAA controllers will feed the landing traffic to the AF-operated Precision Approach (GCA) radar for actual landings at the airbase under IFR conditions. The one exception to this is Kirtland AFB at Albuquerque, N. Mexico, where the CAA will operate both PAR and ASR units since it is a joint military-civil field.

A standard RAPCON installation consists of three Surveillance and two Precision Approach scopes. All equipment is to be provided by the Air Force. CAA personnel to operate the centers will be recruited from existing control towers and en route control centers, according to F. B. Lee.

He did not state whether or not the funds for salaries would be met from CAA allotments. These are already strictly curtailed in economy drives, to the point of eliminating many staff functions and forcing some personnel back down into field ranks, with this in turn displacing some field personnel and increasing the basic workload on those remaining. If the Air Force is paying for the program in total, then many experienced, competent field personnel will have the program to thank for saving their jobs after many years of service. But, if the Air Force tires of the contract after a year or so and additional personnel obviously have had to be employed, what then with CAA purse strings as tight as they are?

This is the key to the civil aviation industry's interest in what would otherwise be a purely military concern. Such an occurrence with the present Federal law would eliminate many career employees who have grown up with the systems, and turn over the airways to comparatively inexperienced ATC personnel taken in from the military.

Collins and Jeppesen Offer Course Computer Cards

As a result of arrangements recently completed between Collins Radio and Jeppesen, users of the Collins NC-101 Course Computer Navigation System may now secure from Jeppesen a complete up-to-date "route" card service with coverage for the entire U.S.A.

The "route" cards are available in standard or special groups, as well as tailored cards for special routes, all of which will be maintained up-to-the-minute by Jeppesen's service.

With this development, JEP and Collins have formed a practical partnership, the first in the industry, to supply the flying public with a coordinated aid for efficient and accurate air navigation.

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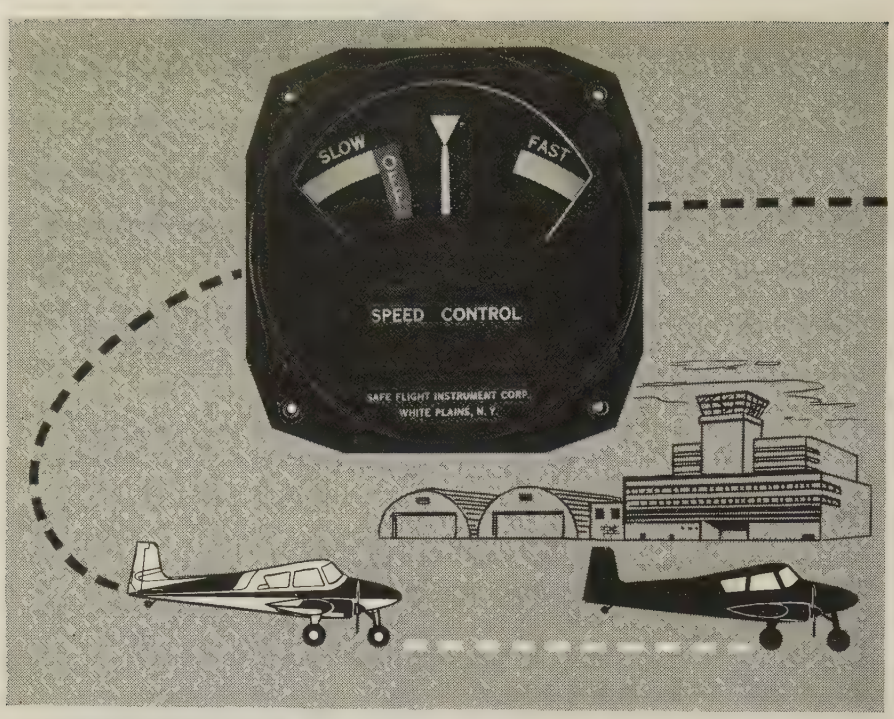

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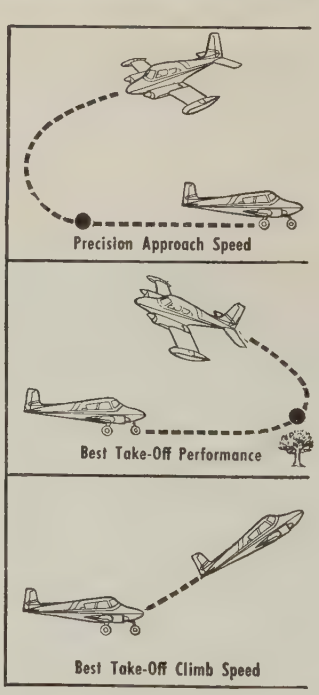

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Jet Transport

(*Continued from page* 28)

Depreciation

It is not re-evaluation of an operation that is involved here, rather a concept. A great deal has been said concerning the high initial cost of turbojet transports, but little has been said regarding the operational life of this type—a factor which must be considered when speaking of costs. Normally, aircraft have been depreciated over a five- to eight-year period due in part to the fact that the obsolescence rate has been relatively high as a result of development of newer and faster types. The faster the airplane, the longer will be its operational life. Due to drag rise and compressibility effects, increases in cruising speeds become difficult at high subsonic speeds. The only possibility of increasing speeds beyond this is to start operating in the supersonic realm, and this will likely require some pronounced aerodynamic and structural refinements as well as greatly improved powerplants. It is quite obvious that due to the disturbing effects of compressibility there will be no continuous operation in the transonic regime, *i.e.* between Mach .9 or .95 to 1.1 or 1.2.

This means, simply, that the economic obsolescence of a jet transport operating in the high subsonic range (near 600 mph) will be exceedingly low due to the fact that it will be operating on the lower boundary of the transonic speed spectrum in which no extended cruising operation will occur. Thus, it is quite probable that jet transports will have a useful life of at least twice that of reciprocating types. This is entirely feasible, for an airframe of sound design, with proper care and maintenance, is capable of remaining in excellent operational condition for a very long period of time (witness the DC-3 and the DC-4, as well as others).

Summary

In the past, aircraft have become obsolete within a relatively short period of time as newer and faster transports became available. Further, it has been true for piston-engined transports that an increase in block speed has been associated with a reduction in operating costs. There is no reason why this trend should not continue with the advent of the turbine transport. To do so, however, will require a re-evaluation of our methods of operation, for some of these methods, while applicable to piston-engined aircraft, must be revised for turbine-transport operation. Doubling operating speeds and altitudes is bound to alter some of our customs.

Therefore, we should streamline our thinking and operations in terms of the end result of increased speeds possible with jet transports and evaluate this airplane on the basis of its full capabilities of utilization. The extended useful life, plus the increased revenue-bearing ton-miles per hour, eventually will result in operating costs comparable to those for reciprocating transports. This will not come about by merely refinements in the airplane alone, but will be equally a function of our ability to streamline operations in keeping with the demands of a jet-transport era.

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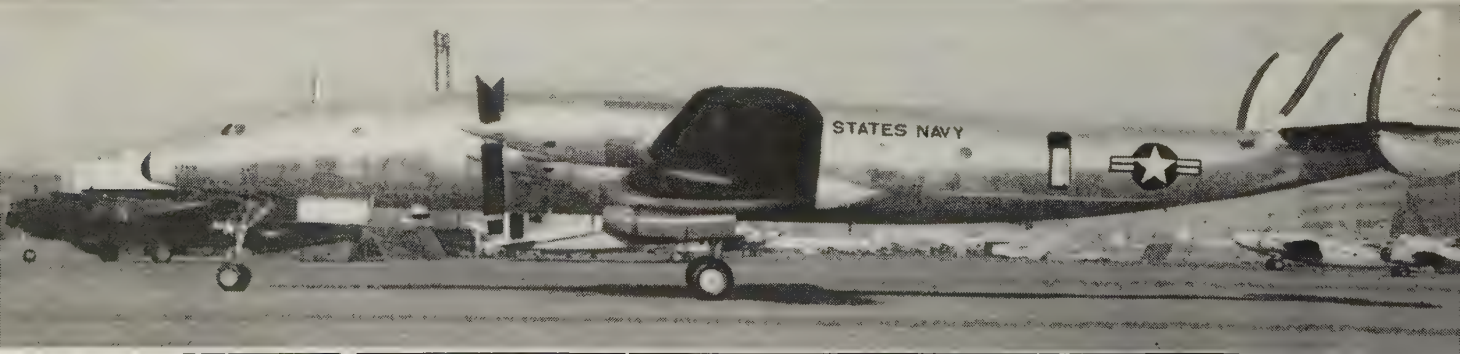


EWEST TRANSPORT CONCEPT is Lockheed's C-130A turbo-prop ault transport, shown here in its dramatic first flight. Now in production at vernment Aircraft Plant No. 6, operated by Lockheed's Georgia Division in Marietta, this giant plane literally jumped off the runway in one-third the distance required for today's commercial transports. This new cargo plane incorporates scores of new features for better handling of troops, materiel and equipment.

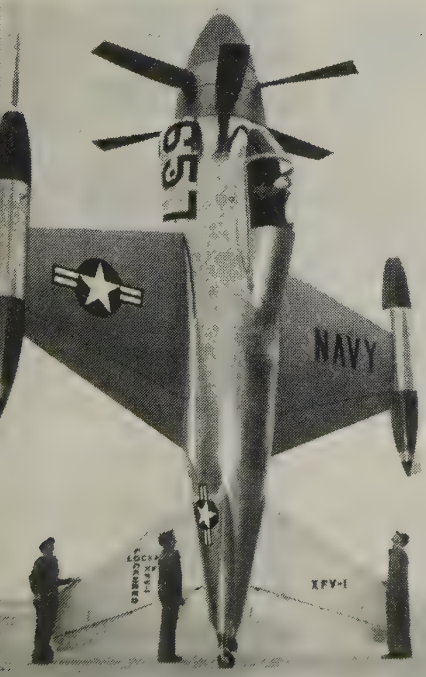
6 New Lockheeds for U.S. Protection

owerful Team Includes Truly Amazing Jet Fighter, High-Speed Assault Transport and Vital Picket Plane

54 has been a notable year for Lockheed, in research, velopment and production. Six new models in one ar include: world's fastest propeller-driven transport; orld's first turbo-prop assault transport; latest ver- on of the Navy's Neptune anti-submarine patrol mber; a new advanced jet trainer for the Navy, and ruly amazing jet fighter, the F-104 now in production, hich is too secret to photograph or describe.

On these pages are shown all new models except the stricted F-104. Also photographed is the vital Super onstellation picket plane, with fantastic top and bottom domes. The bottom radome, for example, creates be- veen 30,000 and 60,000 pounds of drag pressure, yet hold it securely in place only 10 bolts are needed, due ingenious Lockheed design.

LIES STRAIGHT UP, LANDS STRAIGHT OWN. This is the Lockheed XFV-1 Vertical Ascender, revolutionary new concept of aircraft developed in operation with the U.S. Navy. Now, every ship n have its own protective fighter umbrella, every back rd could become a landing field if needed.



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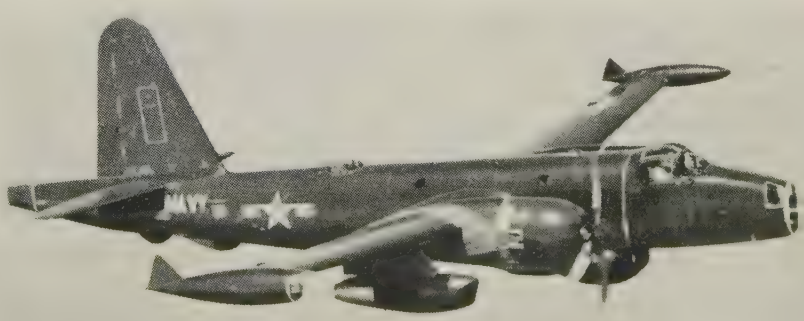


Boundary Layer Control

(*Continued from page* 17)

Mechanical Arrangement

The essential features of a system of *blowing* boundary-layer control are:

1. A primary source of pumping power. This may be the main engines or an auxiliary engine. For large transports, an auxiliary powerplant, probably a turbine engine, is recommended.

2. A method of transmitting the pumping power to the fans. If an auxiliary turbine engine is used, one of the better methods is to use compressor bleed air for driving turbines that power the boundary-layer fans.

3. A system of ducts, usually behind the 60% point of the wing chord, for spanwise air distribution.

4. A blowing slot, disposed ahead and above the single slotted flap, as shown in *Fig. 1.* The width of this slot is an important design variable and must be coordinated with the other design elements of flap-chord ratio, flap deflection, pressure and quantity of the blowing air.

The physical arrangement of the elements of the blowing system is dependent upon the actual design.

The location of the main engine and pumping fans is flexible, but the duct installation and slot-width selection must be closely controlled to secure maximum lifting effectiveness for power consumed.

Design Procedure

Another purpose of this article is to describe the design procedure for a system of boundary-layer control to secure maximum lift with a given expenditure of power. This procedure has been developed at the University of Wichita and depends upon experimental two-dimensional, airfoil data obtained under a contract with the Office of Naval Research, Air Branch. The main steps in the design activity are:

1. Select a wing design in terms of airfoil, span, wing loading, aspect ratio, taper ratio, and twist on the basis of ordinary standards of high-speed, cruise, structural efficiency, and other considerations of importance for the particular airplanes being considered.

2. Perform a span loading analysis, considering lift of the basic wing separately from lift produced by deflecting flaps.

3. Assume a pumping system, consisting of powerplant, ducts, boundary-layer fans, and auxiliaries.

4. Conduct an analysis of the duct losses for various flow quantities.

5. Compute the energy required to force these various quantities of air through a range of slot widths. A narrow slot is approximately 0.05% of the wing chord while a wide slot is about 1.0% of the wing chord.

6. Compute the values for the various flow quantities at varying airspeeds within the operating range.

7. Construct a boundary-layer design chart by combining the information from steps 4, 5, and 6 into a single graph.

8. Determine the effectiveness of blowing flaps as a function of slot width, pumping quantity, and flap deflection. Two-dimensional test data will be required for this.

9. From the flap-effectiveness curves, which identify the maximum deflection angle where the flap will produce an effectiveness equal to thin airfoil theory, the proper combination of flap angle and C_Q can be found.

10. With the maximum deflection of the flap identified, the wing lift coefficient may be read from the plot of wing-lift coefficient *vs.* flap angle and angle of attack, and the assumed value of lift coefficient may be checked.

11. The above process is repeated until the entering assumptions regarding lift coefficient and C_Q are checked against those which are secured from the design procedure. These values are the proper wing operating lift coefficient and pumping quantity. From these, the performance of the aircraft can be calculated.

Wing Design

The selection of the wing characteristics such as aspect ratio, taper ratio, wing section, twist, and plan form need not be unduly influenced by the act of applying blowing boundary-layer control. Since the ultimate goal is to increase flap effectiveness, any wing adaptable to a good flap system will be satisfactory for boundary-layer control, although certain features may be adjusted to better accommodate the boundary-layer control. These are a slightly thicker wing section and lower aspect ratio to provide greater room for internal ducts. The thick wing sections are not desirable in a high-speed airplane, but root thicknesses of 15% to 18% will accommodate adequate ducts.

A high aspect ratio is attractive from the standpoint of reducing the induced drag at the high lift coefficients, but a low aspect ratio is more desirable from the standpoint of providing greater room for internal ducts. Aspect ratios of 7.0 to 8.0 are good compromises between these two conflicting criteria.

After the wing characteristics have been chosen, a span-loading analysis must be performed to determine both the distribution and the variation of lift with angle of attack and flap deflection. A procedure must be used that permits the separation of lift due to angle of attack and the lift produced by the flap. This calculation of span loading will give curves *(Figs. 2* and *3)* that show the loading due to angle of attack and flap deflection separately.

In computing the span loading for each of the above cases, it is necessary to use the proper section-lift-curve slope and flap effectiveness. With regard to lift curve slope, the designer must be aware of the decrease in slope as the airfoil section approaches the stall and make allowances in his calculations for this phenomenon.

In computing the lift due to flap deflection, a value of flap effectiveness must be selected that can be attained by boundary-layer control. Experiments have shown that the effectiveness is equal to or greater than that predicted by thin airfoil theory and a good procedure is to use the theoretical value (*NACA TR1071, 1952*) in the computations. This theoretical value should be used regardless of the flap deflection, since the blowing boundary-layer control can provide an effective flap up to very high deflections.

The span loading curves shown in *Fig. 4* and *Fig. 5* are integrated to secure the total wing-lift coefficient at each angle of attack and at each flap deflection. Additional curves are then plotted to give the lift as a function of the wing angle of attack at zero flap deflection and another curve showing the lift as a function of flap deflection angle, with the wing at zero-lift angle of attack. Computations are then made with different flap spans to determine the best balance between total lift and lateral control. Comparisons with the span loading due to full-span flaps will permit a selection of the flap span, with the remainder of the span devoted to a blowing aileron. Since the effectiveness of an aileron is improved by boundary-layer control, a smaller aileron span will provide sufficient lateral control, even at the lower speed made possible by the greater flap effectiveness and area.

The total wing lift coefficient is determined by adding the lift produced by the wing at a given angle of attack to the lift produced by deflecting the flap. The only questions remaining are (1) what is the maximum allowable angle of attack and (2) what is the maximum allowable flap deflection? Once these maximum values are determined, the wing maximum lift coefficient is fixed.

Pumping Analyses

No generalized procedure exists that permits the designer to read from a set of curves the pumping system best for a particular case. At this point, therefore, the selection of a specific powerplant and pumping system must be assumed by the designer. Since the pumping powerplants will be used only during landing and take-off, they should be as light as possible, but still capable of delivering sufficient power to produce a truly effective flap system. Gas-turbine engines, with power delivery either in the form of shaft power or compressed air, are the lightest type of available powerplant and their high specific fuel consumption rates are no deterrent for a use which occupies such a small portion of the operating time of the aircraft. If a gas turbine is selected, the power will probably be set by the availability of a powerplant, rather than by free choice.

A mechanical arrangement of the pumping units and duct layout must be made with a fairly accurate specification of the duct arrangement. An analysis is then made of the flow losses incurred as various quantities of air flow through the ducts. These losses are determined by straightforward procedures involving turning losses in corners, diffusion losses, skin-friction losses, etc., and are tabulated as a function of the flow quantity.

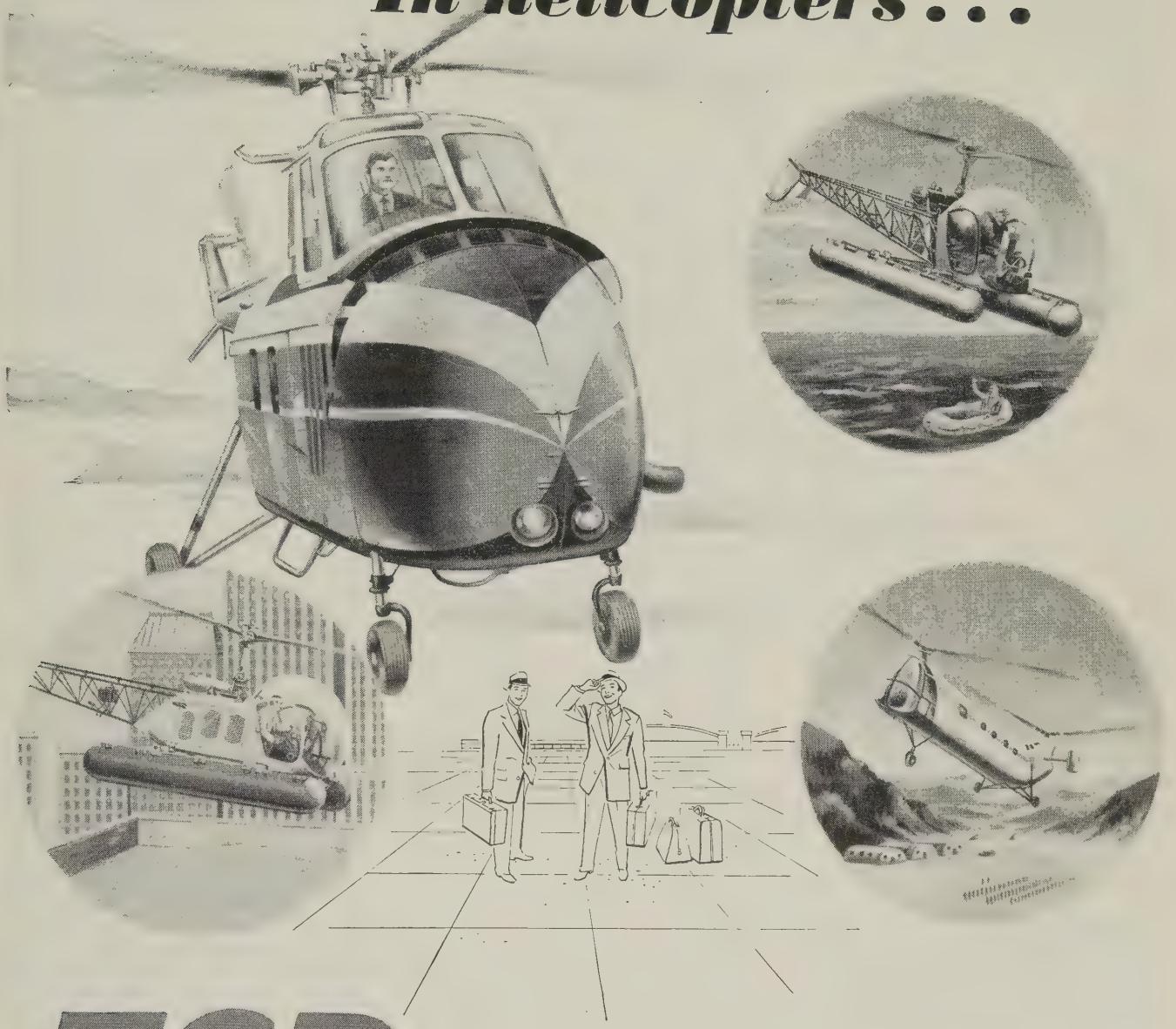
The total power available at the blowing slot ahead of the flap is the power output of the primary powerplant times the pumping efficiency minus the duct losses. The available slot pressure for varying quantities of flow can then be computed.

Boundary-layer Design Chart

The above values may be plotted on what is known as the boundary-layer control design chart which is shown in *Fig. 6.* On the left-hand portion of this curve is a plot of air quantity *vs.* pressure

(*Continued on page* 38)

In helicopters . . .



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Boundary Layer Control

(*Continued from page 36*)

rise, which identifies the corresponding values of pressure rise and quantity which the pumping system is capable of delivering after all pumping losses have been subtracted.

One of the key variables in the boundary-layer system is the width of the blowing slot. This dimension is usually expressed as a percentage of the local wing chord and ranges from .05% to 1.0%. To force varying quantities of flow through the different slot widths requires varying pressures. For each slot width, therefore, a pressure *vs.* quantity curve must be plotted to identify the required pumping pressure. The pressure rise, which is essentially the dynamic pressure of the air flowing from the blowing slot, must be plotted for a series of slot widths, as shown in *Fig. 6*. The intersections of the available pressure *vs.* quantity for each slot width gives the particular quantity flow from the assumed pumping system for each slot width.

The design chart will indicate that the quantity flow decreases quite rapidly as the slot width decreases, because of the higher pressures required for the narrow slots. On the other hand, the duct losses become proportionately higher at the high quantity flows. This restricts the width of the blowing slot to a value that would not permit most of the pumping energy to be dissipated in duct losses.

The boundary-layer design chart is completed by plotting on the same page a graph of the quantity coefficient against the quantity of air for different airspeeds. This graph depicts the equation:

$$C_Q = \frac{Q}{S \times V}$$

where

C_Q = Pumping coefficient
Q = Quantity of air flowing from slot (cu ft/sec)
S = Wing area ahead of blowing slot
V = Airplane flight speed (ft/sec)

To use the boundary-layer design chart, a slot width is first selected, arbitrarily if necessary. The intersection of the quantity flow *vs* pressure-rise curve for this slot width, with the curve of pressure and quantity availability, will establish the flow quantity. This quantity flow is extended to the graph of quantity *vs* C_Q, and for a particular flight speed, a value of C_Q is read. A value of airspeed will have to be assumed at this point, which is merely another way of saying that a value of lift coefficient will have to be assumed. From the assumed lift coefficient and wing loading, the speed may be calculated to determine the C_Q. Iteration soon establishes the C_Q.

Flap Effectiveness

From the boundary-layer design chart for a particular design a combination of slot width, pumping quantity and pressure, and C_Q may be selected with an assumed operating lift coefficient. From the plots of lift coefficient *vs* angle of attack and flap deflection (*Fig. 4* and *Fig. 5*) the values of wing angle of attack and flap deflections can be secured that will be required to produce this particular value of lift coefficient.

It now remains to determine whether the resultant value of C_Q is adequate to produce the theoretical flap effectiveness at the deflection angle as read from the graphs. Two-dimensional section data is required to perform this check. *Fig. 7* shows the necessary type of data. On this graph the variation of lift with angle of attack at constant flap deflection and varying C_Q is described. Similar graphs may be used to plot a flap effectiveness curve as shown in *Fig. 8*. This figure shows at a glance the relative position of the point selected in the above procedure to a theoretical flap.

If the assumed point in terms of slot width, C_Q, and flap deflection lies above the line identified as *Theory*, the flap effectiveness is as good as was assumed for the span loading, and the assumed lift coefficient can actually be attained. If the combination of slot width, C_Q, and flap deflection produces a point below the *Theory* line, the flap effectiveness is less than was used for the span-loading calculation and a new assumption is required. The designer must select a new value of slot width, adjust his lift coefficient assumptions, and repeat the procedure. Two or three trials should be sufficient to give a proper combination of these parameters.

One of the key factors in this design procedure is the availability of detailed section data. If this data is not available, the assumption cannot be checked and an arbitrary design must be made with verification by testing. The program of the Office of Naval Research at the University of Wichita has been planned to produce this necessary type of data. Reports that furnish this data are available through the Air Branch of ONR.

Wing Drag

With the values of slot width, pumping quantity, pumping power, and wing lift coefficient determined, the polar curve for the particular wing is computed. The primary contribution to the total drag will be the induced drag of the wing. The values of profile drag given in conventional literature pertaining to wings equipped with flaps at high deflections are not useable for this particular case. A boundary-layer-control flap approaches a theoretical flap by operating with completely unseparated flow and for this reason the profile drag is small. At the higher lift coefficients, in fact, the profile drag may be negligible with respect to the wing-induced drag. For a first approximation, therefore, the conventional induced drag equation, $C_{D_i} = \frac{CL^2}{\pi A}$ will describe the total wing drag. The use of this drag value, together with the parasitic drag contributed by the fuselage, nacelle, landing gear and tail surfaces, will provide a fairly complete picture of the total drag of the aircraft. This total drag may be used to compute performance with reasonable accuracy.

Several conclusions can now be drawn concerning the use of this wing equipped with a boundary-layer-control system by blowing. In the first place, the aircraft will operate at a lower speed. The most important point associated with this ability to operate at lower speeds is the variation of thrust horsepower in both propeller-driven and jet-propelled aircraft. To date, the selection of propellers in terms of diameter, number of blades, solidity, and similar factors has been made on the basis of efficiency during the climb and at high speed. For conventional aircraft these speeds are not too widely separated and a prop may be designed with reasonable efficiency under both conditions. This is particularly true of constant-speed props.

With a boundary-layer-control wing, the aircraft is capable of flying at sufficiently low speeds that the thrust horsepower of the conventional propeller, as selected above, will drop rather severely at the low forward speed *(Fig. 9)*. This means that the available power for climb and acceleration is reduced. A performance penalty will be incurred, therefore, by virtue of operating at lower speeds where the propeller efficiency is much lower.

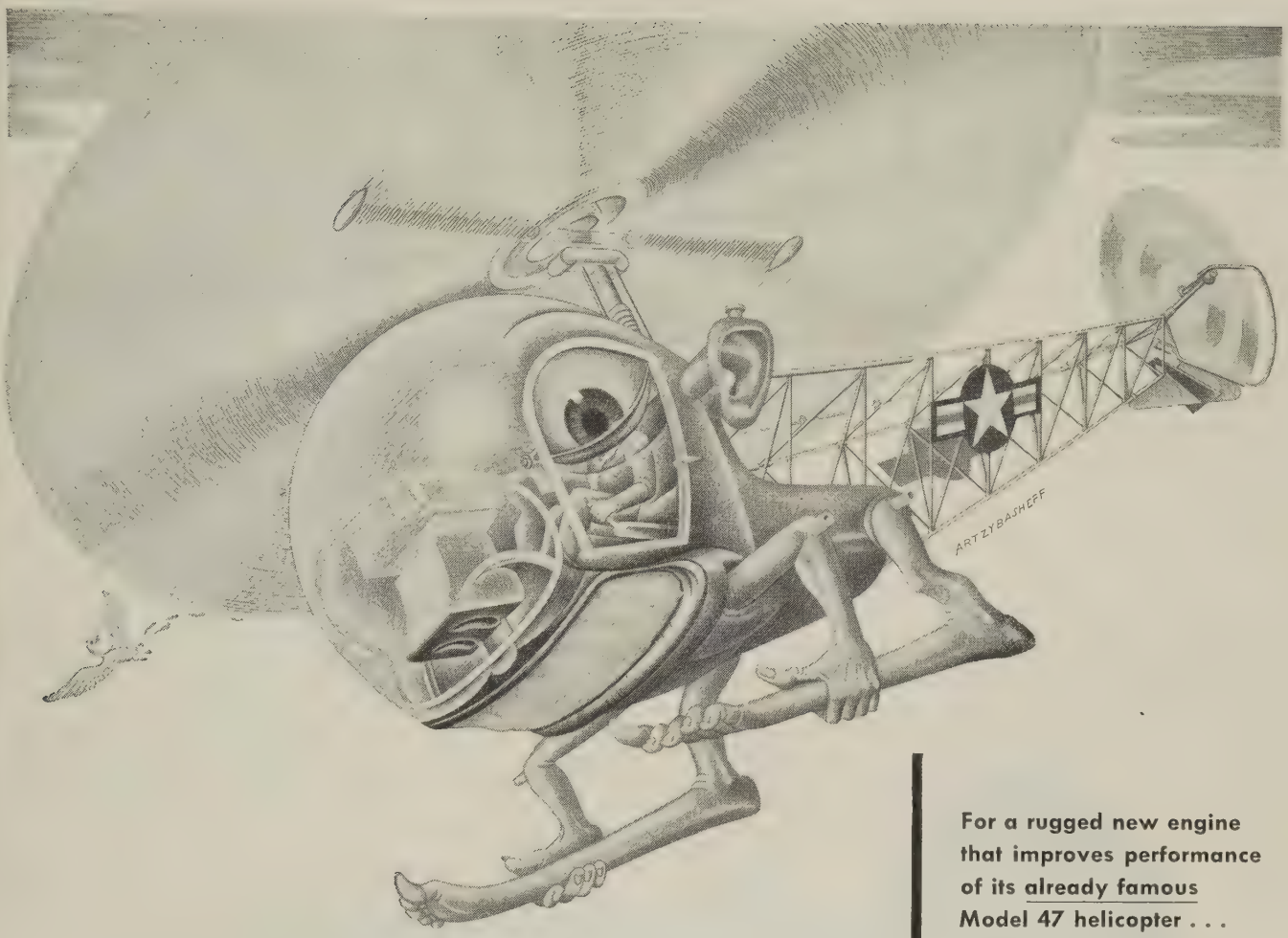
The solution to this problem is to design the propeller to have a higher efficiency at the new climb speed. This can be done by adjusting tip speed, propeller diameter, number of blades, and solidity, until a propeller is obtained with higher efficiency at the lower speed. With this more efficient propeller, the aircraft will have more thrust horsepower available at the lower speed and the climb and take-off performance will be increased. The neglect of this point in the past has led to the conclusion that the boundary-layer-control airplane would be severely penalized in the climb due to the higher induced drag. The polar curves, however, show that the actual horsepower required at the lower speeds, even at the very high drag coefficients, is no more than that required at ordinary climb speeds. The real penalty is produced by the lower propeller efficiency which reduces the available thrust horsepower.

Since the thrust of a jet engine is essentially constant at all speeds, some lower limit on flight speed exists where the available thrust horsepower is less than the required horsepower. The jet-propelled aircraft, therefore, may not be able to utilize lift coefficients as high as the propeller-driven aircraft can use.

Secondary influences as a result of the interaction of the slip stream and the wing flow are more pronounced on aircraft equipped with boundary-layer control. The completely unseparated flaps are much more effective in deflecting the slip stream than conventional flaps. The value of the thrust force, therefore, is reflected to a larger extent in an increased lift on the wing surfaces. This is another way of saying that the lift coefficient is greater with power on than with power off. The increment due to power in the case of the boundary-layer-control airplane appears to be considerably higher than the increment due to power in the conventional airplanes. The presence of the initial high-lift coefficient together with a higher increment due to power will produce lift coefficients of higher value than heretofore possible.

Other factors, such as the influence of slow-turning propellers on the control and

(*Continued on page 40*)



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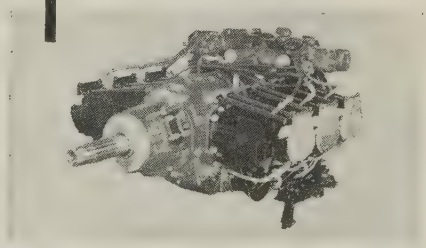

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Boundary Layer Control

(*Continued from page* 38)

stability of the aircraft, must be considered. The designer will find himself attracted, as he performs the design problem using boundary-layer control, to higher and higher flap deflections and higher and higher propellers until a condition exists where severe unbalance would result from failure of a single powerplant. At this point, it becomes wise to stop and judge the value of further aerodynamic performance improvements against the cost of making some mechanical arrangement to control this aircraft in the event of single engine failure. Techniques such as coupled powerplants and pumping over both horizontal and vertical tail surfaces are probably quite necessary for aircraft with extremely high values of lift.

Conclusion

This paper has presented a procedure utilizing recent, two-dimensional data that makes it possible for a designer to examine, for a particular design and with a given pumping power, the results of blowing boundary-layer control. The procedure permits the precise selection of design details such as slot width, flap deflection, and flap span, and determines the resultant aerodynamic characteristics.

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Mary Locklier is happy — and we're ALL happy — about the major role Southwest Airmotive was privileged to play in planning and staging the National Business Aircraft Association's epochal 1954 convention. With others from throughout the land, we had a hand in shaping real aviation history in keeping with a 22-year-old SAC tradition of supporting worthy industry projects.
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Skyways Round Table

(*Continued from page* 20)

of the runways from the standpoint of their landing characteristics and safety. We have asked our design people, our operation and maintenance people as well as the engineering people, to come up with a device that would establish for us the coefficient of friction that can be obtained on various types of runway surfaces.

"In any damp or rainy condition, the coefficient of friction is low compared to that of a dry runway. We are interested in developing a portable measuring device which can be used under a wet-runway condition to determine surface friction. If the friction coefficient has deteriorated due to oil slick, etc., the surface of the runway can be scarified or treated so that we provide as good a surface as possible."

Harold Hoekstra: *"Mr. Sullivan has touched on a very important point in his mention of the surface coefficient of friction. I might point out that the CAA is having studies made on that phase.*

"To get back to Bob McGuire's point, belly landings, I was thinking in terms of lowering a shoe of some sort from the aircraft. This would take some load off the tires and put it directly on whatever is the means of friction."

O. L. Wilkinson: "It would seem to me that you would still have to have some means of varying the amount of weight or braking effect that you receive from these shoes if they were placed so as to give you a differential effect across the airplane, span-wise. Running across patches of oil, sand and dirt, conditions of ice or puddles of water would change the coefficient and you would still to have some means of preventing a sideslip which might possibly result in a ground loop.

"Regarding coefficient of friction, there are cases on dry concrete runways where the coefficient is such that there is no slippage of tire but rather a shearing of the rubber."

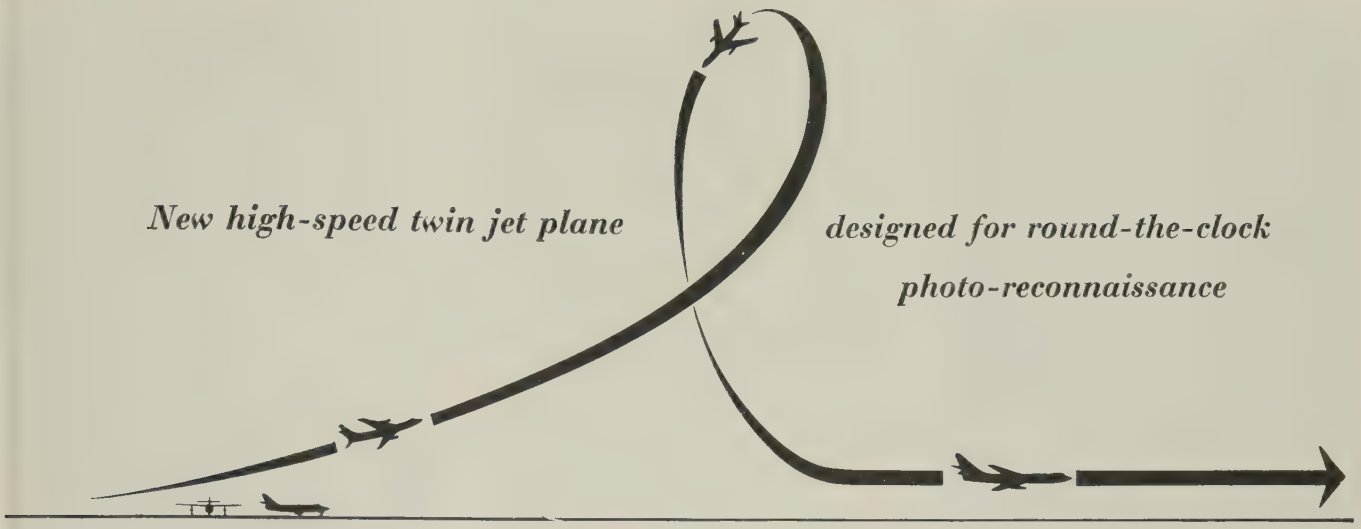
T. E. Cooper: "I'd like to ask this group what importance they feel tire-tread design might have on the over-all braking problem. We had a recent incident which brought to our attention the fact that possibly the anti-skid qualities of some tires aren't as good as others, and that more importance should be shown to actual tire-tread design with regard to skid characteristics."

R. C. McGuire: "The coefficient between the tire and the ground obviously is a function of tread design, the condition of the tire, and might even involve the over-all diameter or inflation of adjacent tires. Slightly different tread conditions or slightly different friction conditions between the ground and the tire always exist on the average airplane. It is impossible to keep the tire and the ground coefficient constant. However, I don't think that the anti-skid qualities of new tires differ greatly. We may be talking about changes in coefficient of 5%, which may be negligible when you consider all the variables in a complete stop."

Reversing Props & Jet Reversers

Harold Hoekstra: *"Let's now turn to a second main area. This is the use of the powerplant in one form or another to help*

(*Continued on page* 42)



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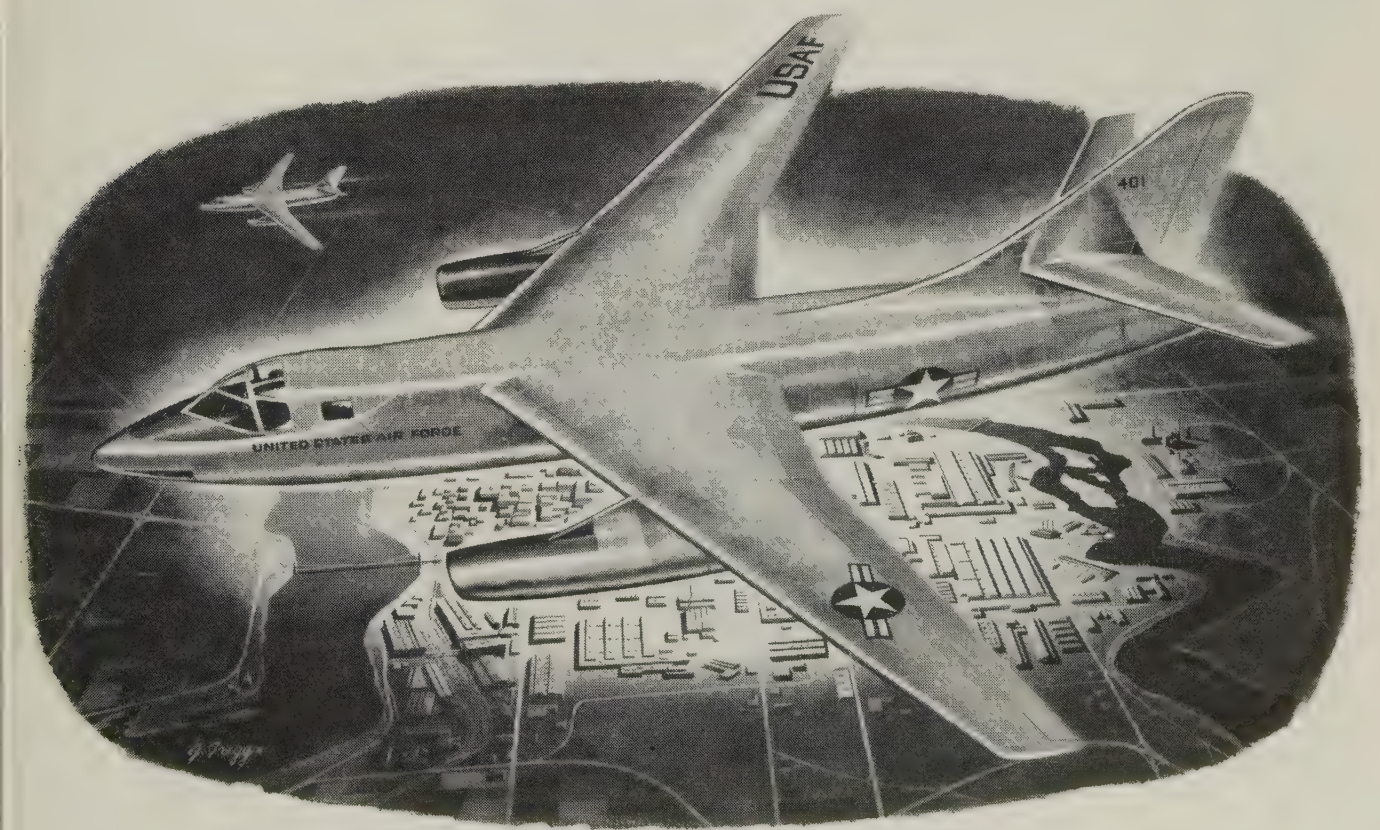
Development of RB-66 is another example of Douglas leadership in aviation. Planes that can be produced in volume to fly *faster and farther with a bigger payload* are a basic rule of Douglas design.



Enlist to fly in the U. S. Air Force

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Skyways Round Table

(*Continued from page 40*)

us decelerate, stop or brake the aircraft.

"Tom Cooper, would you care to go into the prop-reversing phase?"

T. E. Cooper: "Propeller reversing is definitely here to stay. There have been a lot of problems in connection with the control of the system, but I think we are gradually getting the system down to a point where we can fully depend on it. Eventually, we probably will be able to obtain shorter runway distances because we have propeller reversing. In general, most of the pilots use prop reversing on every landing where it is applicable, and it has been highly satisfactory. We're all for it. As far as the future is concerned, we will no doubt require it."

R. C. McGuire: "The development of prop reversing was timely because it came when wing loadings were becoming higher and airplanes heavier. Stop distances would have become longer on some aircraft, had it not been for reversing propellers.

"The average transport operator likes to certificate the airplane with brakes only, holding reverse thrust in reserve for stopping under conditions where the ground coefficient might not be as high as it was during certification tests. For these reasons, I am certain reverse thrust is here to stay."

Harold Hoekstra: *"One phase of the prop-reversing picture is the possibility of damage to propellers by kicking up a lot of material that may be on the runway."*

T. E. Cooper: "The big problem is trying to get a coordinated effort between the airline operators and the airport personnel to keep the runways clear of stones and miscellaneous objects. Undoubtedly, there are some types of blades that are more susceptible to damage during reversing than others, but our experience has been that if the pilot himself recognizes that certain airports are in a somewhat hazardous condition, they just don't use prop reversing and are probably more careful where they land on the runway. Under these conditions they rely more on their brakes for stopping. Objects on the runway probably will be eliminated in the future. Some airports actually make concerted efforts to clean runways. There is definite improvement along that line.

Tom Sullivan: "Dirty runways gave us considerable concern when we took over the operation of the airports. To make sure runways were clean and free of debris, the Port Authority purchased considerable sweeping equipment. Then we found that even though we swept the runways, such small bits of debris as nuts and bolts were not always picked up by the equipment. We, therefore, came up with a rather ingenious device which is a magnet-controlled plate. Periodically, we run it the length of the runways and pick up an assortment of metal debris. I'm sure all airport operators operate under the same housekeeping procedures as we do, so there shouldn't be any problems in that department."

Harold Hoekstra: *"Mr. Sullivan's comments on the equipment used for cleaning runways and his experience with it is particularly important from the standpoint of future operations with turbine-powered aircraft where the problem of picking up material and getting it into the intakes of turbine compressors is potentially serious.*

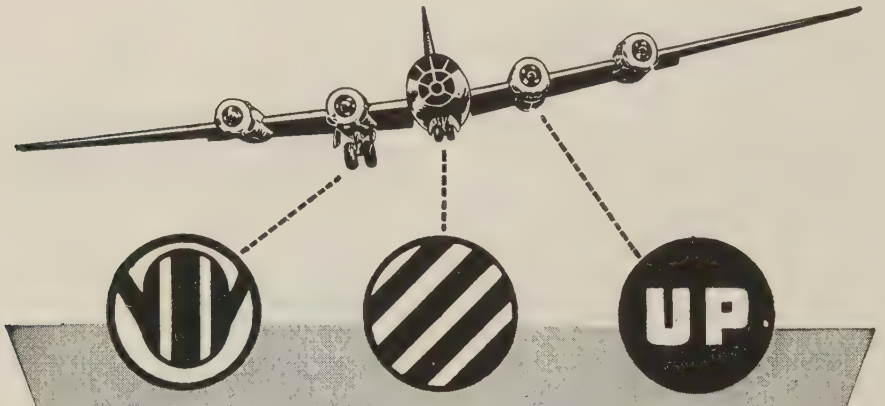
"Herb Fisher, you were one of the pioneers in this prop-reversal business. Would you add to the discussion?"

Herbert O. Fisher *(Chief, Aviation Development Div., Port of N. Y. Authority):*

"One thought that comes into prominence in considering the use of prop reversing, is pilot technique. When you allow the airplane to decelerate to a speed of 80 or 90 mph, then you apply power and have reversing on for 1,000 or 1500 feet, you are exposing the prop blades during that period to whatever debris happens to be on the runway. On the other hand, if you reverse the propeller at the earliest possible moment after touchdown, you derive a greater braking in a shorter period of time. This is because the higher the forward velocity, the greater the braking action and the greater the deceleration.

"I also feel that if prop reversing were used properly, it would extend the life of your tires and reduce propeller abrasion considerably. In most cases—and I've watched it many times—the pilot making a landing rolls at least 1,000 to 1500 feet before he reverses the props. Then he obverses his propellers and starts applying the brakes when he's traveling at about 50 mph. All that is extra wear on the tires and it could be reduced if the pilot would apply his reversing props more efficiently.

"Prop reversing is the finest brake system we know of today. The only system that will stop you shorter is the barrier."



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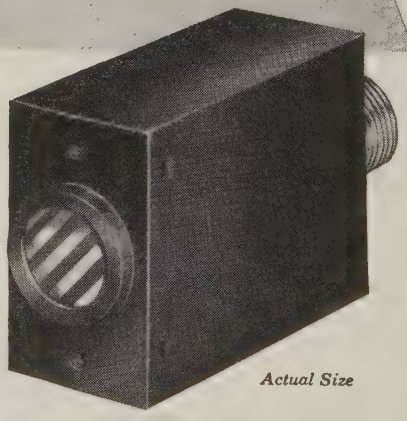

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Harold Hoekstra: *"In other words, propeller reversing has its greatest merit at the high-speed end of the run where it can really grab hold and cut down the distance-eating part of the landing cycle.*

"Let's turn now to the problem of reversing by powerplant means through the use of reverse jet thrust. We have Bob Nordli here from Wright Air Development Center at Dayton. Bob, will you tell us something about reverse jet thrust?"

Robert L. Nordli *(Asst. Chief, Engine Installation Sect., USAF):* "Shortly after the war, the French SNECMA organization came out with a device called an aerodynamic-type thrust reverser. We have defined this aerodynamic-type device as one that creates a condition or an effect in the exhaust gases that cause the gases to deviate from their normal flow path. This differs from earlier mechanical-blockage type devices in that with mechanical-blockage type devices a physical obstruction is placed in the flow-path. It is purely a brute-force means; some impediment is placed in the flow stream to turn these gases. There are several drawbacks with the mechanical-blockage type device—weight is one, another is the necessity for actuation devices, and finally, you have a very limited space in which to install this equipment in jet fighters. Therefore, the aerodynamic-type device which SNECMA developed appears to have considerable merit above and beyond that of the mechanical-blockage type.

"The Air Force began an investigation of this SNECMA device in the early part of 1951. We investigated the characteristics of the device; we made three test models, and then we placed the device on a test-stand and tested it with a full-scale engine. Later, we installed it on an F-84F aircraft. The device was quite satisfactory and we felt that it was particularly adaptable to this type of aircraft as well as to others."

Harold Hoekstra: *"Bob, I think it might be helpful at this point to give us an indication of how much reverse thrust we can look forward to in the future. Is it 40% of the thrust of a jet engine, 50% or 60%? Also, what penalty do we pay in the unreversed or obversed condition?"*

R. L. Nordli: "The airline people probably will be as concerned about that as the Air Force since they are very economy-minded. We originally established a maximum thrust-loss value of 5%. This is quite high, but we chose that value to allow freedom and flexibility in our program. After we have developed several types of devices for reversing thrust, we probably will become more stringent on this requirement. In addition, we feel that the total decrease in aircraft airspeed at V-max should not exceed 1% when the reverser is not in operation, and the weight of the device should not be over 120 pounds for application on a 5,000-pound thrust engine. We also have several other requirements, such as not having any adverse effect on the engine operation when we actuate the device and not generating any assymetrical thrust or flow during actuation which might cause a pitch or yaw moment. We are also concerned about the effect of forward-flowing gas on the control and fuselage surfaces.

"As far as the amount of reverse thrust that is required, the Air Force feels that a value of reverse thrust ranging between 35% and 40% should be sufficient.

"For the F-84F, which has a landing weight of approximately 17,000 pounds, we can bring the aircraft to a complete stop with brakes in about 2500 or 3,000 feet. With a reverse thrust of 20% of the basic engine thrust, we can bring the aircraft to a stop in approximately 3,000 feet without using the conventional wheel-braking means. With a reverse thrust of 40%, we can cut this roll down. Using brakes in conjunction with it, the total roll distance can be reduced to 1200 or 1400 feet."

Harold Hoekstra: *"Mr. Frankel of Marquardt could not be here, but he has pointed out to us that his company is now in the process of developing a mechanical-blockage type of reverse-thrust system, and that they have progressed through a scale-model testing stage and will shortly go into full hardware development. Through a unique linkage system they have been able to adjust the area as needed.*

"Bob Nordli mentioned control surfaces and the effect on the aircraft itself. I'd like to get a word from Tom Cooper and Bob McGuire as to what they think all this hot gas going backward and then forward again is going to do to a transport."

T. E. Cooper: "We definitely do not want to see exhaust gases directed toward any structural part of the airplane. In the case of many of our aircraft today, for example, we have the problem of corrosion from exhaust gases, and corrosion can get

(*Continued on page 44*)

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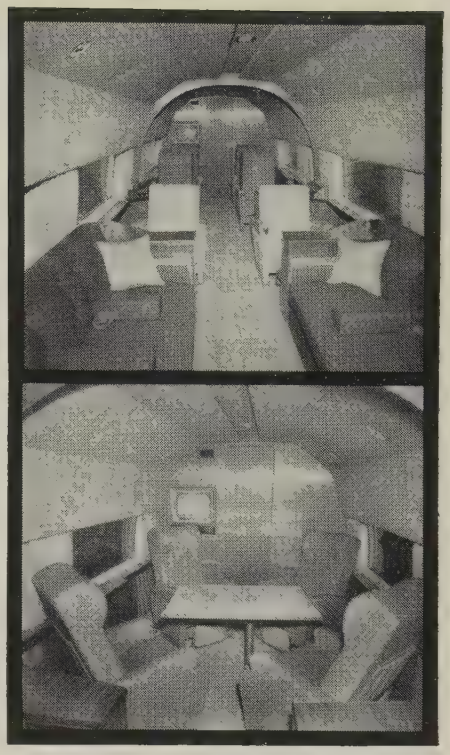

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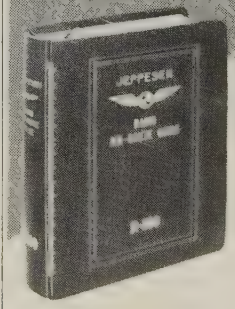

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Skyways Round Table

(*Continued from page* 43)

you into plenty of trouble if you don't take care of it properly. We are continuously working toward a means of keeping exhaust gases directed entirely away from any structural part of the airplane. I would hate to see the exhaust gases directed toward the flaps, wing area or any part of the fuselage, as they might be in a reverse-jet operation. It would mean a terrific cleaning problem and all the associated corrosion that goes with it."

R. C. McGuire: "That reflects Eastern's sentiments, too. We have had a lot of experience with corrosion.

"Jet transports with the engines installed adjacent to the fuselage are going to look messy after a few landings."

Tom Sullivan: "In the earlier design development of aircraft the angle of incidence, particularly on fighter aircraft, was such that the deflection of heat on the runway gave us considerable concern, particularly with asphalt runways. But now that the pod itself is beginning to level out, it appears that we'll have no great worry. Let's not start shooting the gases down toward the runway again."

R. L. Nordli: "Mr. Fisher pointed out that in the case of prop reversal it should be actuated very shortly after touchdown, and my thought is that the same principle applies to a reverse-thrust device for jet aircraft. Because of the temperature problem, you should probably use the reverse-jet thrust early to prevent aircraft surface heating. This device probably will have to be operated almost immediately after touchdown because of the need for a low lag time from forward thrust to reverse thrust. For that reason, a thrust reverser is actually a type of device that will give us a thrust spoiling action as well as a reverse thrust action. Prior to touchdown, it probably will be necessary to dissipate this forward thrust energy and spoil it; then immediately after touchdown, reverse it to obtain a decelerating force."

O. L. Wilkinson: "Do you think either Eastern or Northwest is going to be willing to carry the weight such a device would entail? One of the aircraft manufacturers recently informed me that the weight of a reverse-thrust device would be about 200 pounds per engine in the 10,000-pound thrust class. This means that a four-engine transport would be carrying approximately 800 pounds additional weight."

R. C. McGuire: "I think that 200 pounds per engine is excessive. I also feel, however, that this weight will tend to come down as the art of reverse-thrust design improves. We are now talking about early breadboard models. There should be an appreciable weight decrease in this equipment in the future.

"To my way of thinking, wheel braking will not entirely replace aerodynamic. They both have their individual applications."

Herb Fisher: "I'd like to clarify one point in my mind. You indicated wheel braking will not replace aerodynamic braking. My interpretation is that aerodynamic braking supplements wheel braking."

Harold Hoekstra: *"Bob Nordli, I'd like to ask you this. From the airlines' standpoint, engines have overhaul periods of 1,000 hours or more. From what you have*

seen so far of reverse-thrust devices, are we going to get a lot of hours out of such high-temperature mechanical coal scuttles as we have to put on these engines?"

R. L. Nordli: "I don't see any great problem with the life of the reverse-thrust components. The devices we have developed and tested to date have been quite satisfactory. The only thing we have to be careful with on this type of equipment is to allow for proper thermal motion of reverser components. It probably will be similar in construction to the types of flame holders we now have, where all the pieces are relatively loose under cold conditions. I don't see any problem with materials."

Harold Hoekstra: *"Have you found any particular points that you'd care to bring out on the use of reverse-thrust propellers with turboprop engines?"*

R. L. Nordli: "We have had little flight experience as yet with turboprop aircraft, so I can't comment on it. One thing we are concerned about is the problem associated with the ingestion of foreign articles."

Aerodynamic Braking

Harold Hoekstra: *"In considering the over-all aerodynamic problem of braking aircraft, let's touch on what we can expect from flaps, spoilers, parachutes, etc."*

R. C. McGuire: "For obvious reasons, the future jet airplane will have plenty of flap. In the first place, the airplane is going to be much cleaner; it's going to have a higher wing-loading, and in order to get satisfactory approach and landing performance, the flap area and the type of flap used will be much more efficient.

"It will also be more efficient for take-off. As I recall, the improved flap system on the DC-7 actually reduced take-off distance by approximately 900 feet.

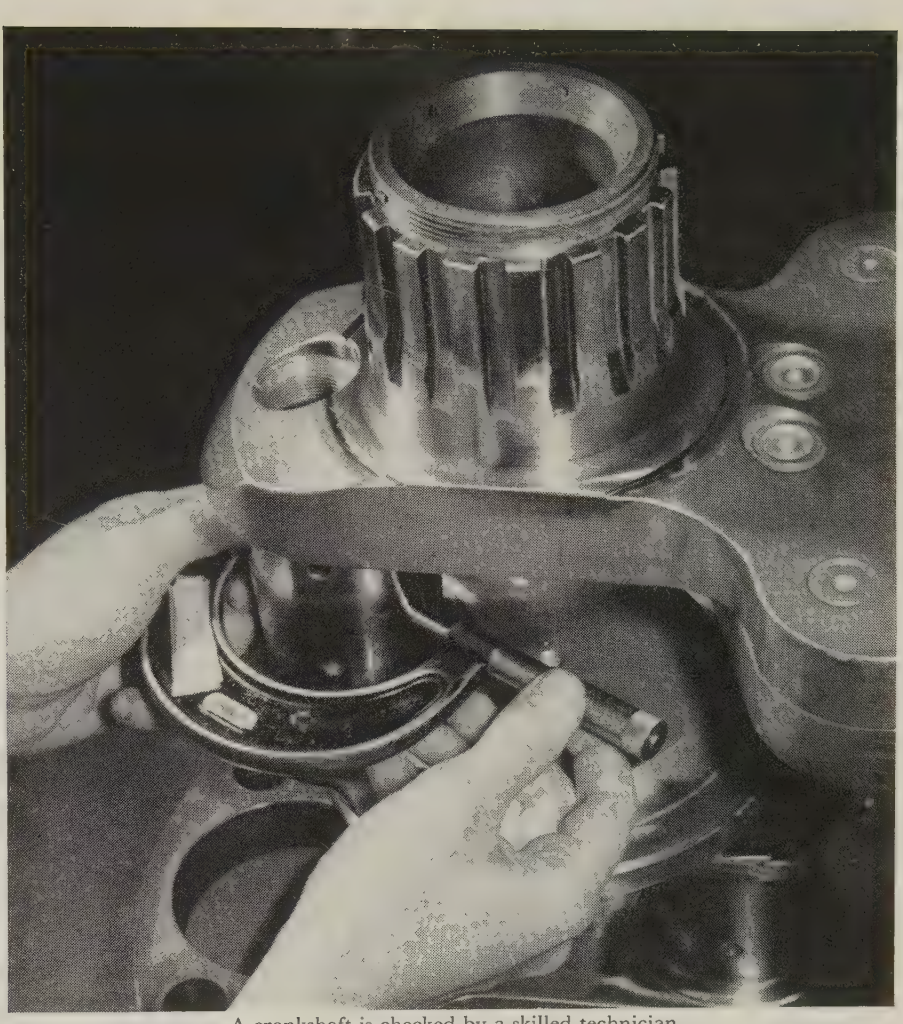
"As for parachutes, if reverse-thrust devices on jet transports continue to be as heavy as they now are, one of the ways in which weight might be overcome would be to rely on bigger and better brakes and a parachute. However, the parachute will probably not be acceptable to commercial operators except as emergency equipment.

"Speaking of spoilers, I think someone mentioned earlier that any jet reverse-thrust device induces a certain amount of spoiling action. Therefore, the use of spoilers to get the weight on the wheels as quickly as possible is contingent upon the type and performance of the airplane."

T. E. Cooper: "As speeds go up and weights increase, the airframe manufacturer has to make use of more efficient flaps and spoilers. I don't particularly like the idea of a parachute to stop a commercial airliner, and I feel that we should stay with jet reverse thrust or heavier brakes rather than attempt a parachute operation."

R. L. Nordli: "The 200-pound figure that has been interjected into the discussion is a little high. The total incorporated weight in the aircraft would probably be under 160 pounds. As far as the Air Force is concerned, we feel there are a number of items that could either be eliminated or the weights reduced to balance out the extra weight of the reverser. For example, if we can use this reverse-thrust device in the air during descent, we could probably eliminate the dive brakes, which would

(*Continued on page* 46)



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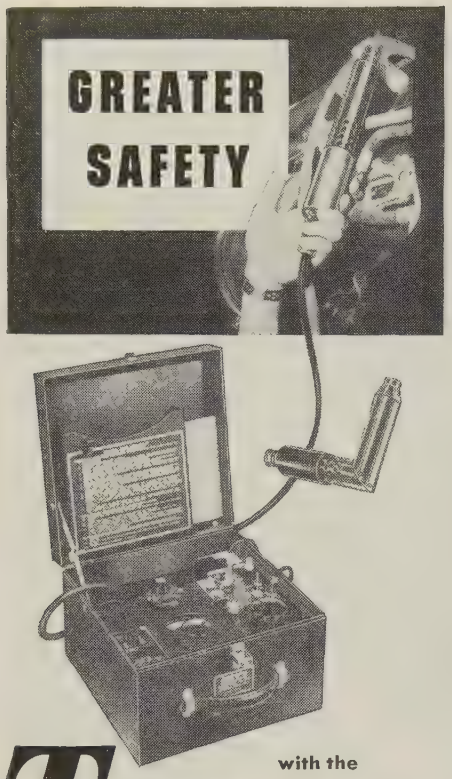

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Skyways Round Table

(*Continued from page* 45)

more than compensate for the weight of the reverser."

M. H. Snedeker: "If I understand you correctly, I believe you had in mind the substitution of this device in flight for a spoiler or a certain amount of flap."

R. L. Nordli: "There is a multiplicity of purposes for use of reverse thrust in flight. One is for decreasing airspeed during descent, for deceleration on the ground, and for evasive action in the air both on approach of a slow-moving target aircraft and for getting away from an enemy aircraft. There are a number of reasons why this reverse thrust should be used in the air, from a military standpoint."

R. C. McGuire: "There is a definite reason for a speed brake on modern aircraft, and there will be a bigger need for it on the turbine transport. This involves clear-air turbulence which becomes more critical with high wing-loadings and increased speeds. At the present time, in order to keep the structure and the speed within bounds, pilots drop flaps to slow the airplane. However, the DC-7B's which Eastern will receive next year will be able to drop the main landing gear to slow the airplane. The turbine transport obviously will need something to slow it down more quickly. That something might be an automatic device contingent upon reliability. Whether or not a tailpipe reverse gadget can be used for that purpose is a moot question. Frankly, I prefer to see a conventional speed brake used."

R. L. Nordli: "If you had a reverser that could provide a spoiling action, it would be wise to use it as a spoiler. The one problem here that you'd have to cope with in a turbine engine would be the lag time for accelerating your engine from an idle condition to a full-thrust condition. If, under emergency conditions, you required thrust to go around again, you just wouldn't have it unless you had the engine RPM. And you can't tolerate high engine RPM because of the thrust that is being generated. So what are you going to do? Are you going to spoil thrust and use it in flight or are you going to just eliminate the possibility of go-round?"

Harold Hoekstra: *"I think there is a mid-course between the use of reverse thrust in flight and keeping the engine RPM. For example, compressor bleed valves will kill thrust effectively, allowing you to keep up engine RPM for the emergency go-round condition.*

"Now, gentlemen, what about boundary layer control?"

Leo A. Geyer (*Asst. Chief of Aerodynamics, Grumman*): "About two years ago at the request of the Navy Bureau of Aeronautics, we began a project involving the application of boundary layer control to a jet fighter-type of aircraft to increase its maximum lift capabilities. Increased lift can be utilized to lower the take-off and landing airspeeds, thus reducing the wear and tear on an aircraft carrier's launching and arresting equipment and permitting a reduction of wind required over the carrier deck. Increased lift also can be utilized to allow a given airplane to take off at a greater gross weight.

"There are several different forms of boundary layer control being actively studied and tested at the present time. The suction type is probably most commonly known. Considerable flight testing has been done with this type by the Air Force and NACA. Secondly, there is the suction-and-blowing system, sometimes called the Arado system, where the air sucked off the outer wing panels is blown out over the inner wing flapped area. And thirdly, there is the pure blowing type on which we have been concentrating. All forms of blowing or suction-type boundary layer control require a source of energy. In the past this has been a pump driven by the main engine or a completely separate engine-pump combination. With the advent of the jet engine, a very efficient compressor is available in the engine itself. This furnishes high-pressure air which can operate an ejector or air turbine driven pump, or which can be piped over the surface of the wing to achieve the increased lift.

"The F9F-4 installation is our first introduction, let's say, to flying a jet aircraft with boundary layer control, and it has been quite successful. With this airplane we have achieved about 10 knots reduction in stall speed and about 15 to 20 knots reduction in approach speed. This reduction in approach speed is something we did not expect. Actually, boundary layer control has improved the controllability of the airplane, and this has resulted in allowing the pilot to make his approach with a smaller margin between stall and approach speed.

"With regard to propeller-driven aircraft such as you have been discussing today, we do not at the present time see any simple way of obtaining this source of high-pressure air. On the F9F-4 we are using, compressor bleed air mass flows much higher than that the reciprocating or turboprop powerplants could possible provide. However, we are only at the beginning of the development of the blowing-type boundary layer control and we feel sure that improvements can be made in the efficiency of the system so that much less engine bleed air will be required."

Harold Hoekstra: *"The boundary layer control approach is bound to be of extreme interest to the commercial operators and manufacturers. There are, of course, problems associated with it, such as the reliability of the power source, keeping the slats or porous surfaces open under icing conditions, the question of dust, oil, etc."*

R. C. McGuire: "We now take extreme care in keeping the airspeed static system salt-shakers open on the side of the airplane. These are a few small holes which can be clogged with dust, dirt or polishing grit. When I think about boundary layer control with its multitude of ducts and bleed holes, I'd say that it would be almost impossible to maintain with present-day methods."

T. E. Cooper: "Another problem that is likely to come up involves winter operations when you are subject to icing conditions. The wings are going to have to be adequately heated so there'll be absolutely no ice on them."

L. A. Geyer: "The problem of icing is certainly important in any type of boundary layer control and a clean wing is essential. In our system we actually have a

(*Continued on page* 51)

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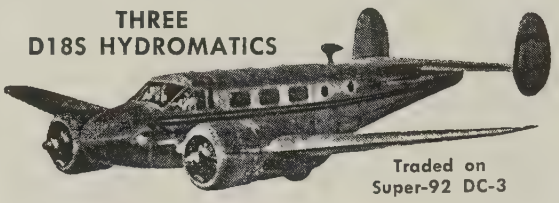

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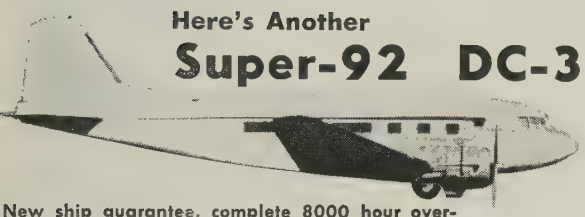

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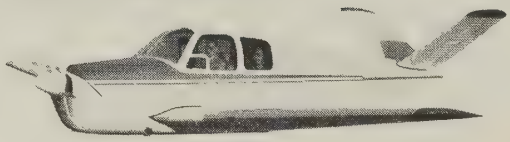

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(*Continued from page 49*)

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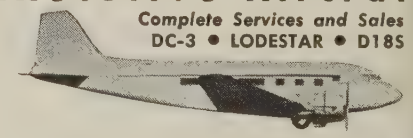

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Skyways Round Table

(*Continued from page 46*)

form of thermal de-icing since the bleed air is in the neighborhood of 400° or 500° F. in the wing ducts. The F9F-4 system is extremely simple and maintenance problems in many hours of flight time on an experimental installation have been remarkably few. The compressor bleed air is just ducted directly out into the wing and blown over the wing flap. It would seem that the suction-type of boundry layer control does have a fundamental icing problem since the boundary layer is removed through a porous surface. That does not seem so practical when the aircraft may have to stand on a ramp for any period of time during winter."

R. L. Nordli: "Is the system that you have compatible with the operation of the jet aircraft during let-down, for instance, when you are going to want to use the available bleed air for anti-icing? Is it possible that the need of bleed air for things in addition to boundary layer control is going to exceed the amount available from your engine under retarded power?"

L. A. Geyer: "In the case of existing powerplants such as the J-33 or the J-48, the situation is a bit marginal at the present time. However, the engine builders are trying to increase the amount of bleed air in future powerplants. We don't think this is going to be a problem.

"The most critical point is not in the approach condition, but rather in take-off when you're operating at 100% RPM. That is where we are going to have the most critical problem of getting the required amount of bleed air without over-temperaturing the engine or resulting in a serious thrust loss."

Harold Hoekstra: "*Mr. Geyer has touched on a very important point, one that ties in with the reliability of the power source, because the critical condition for the aircraft itself, is in the take-off configuration.*

"*Before we close the meeting, let's get into the ground equipment phase of the discussion. Tom Sullivan, would you give us your thoughts on that?*"

Ground Equipment

Tom Sullivan: "*SKYWAYS* certainly should be complimented for highlighting the problems of braking and bringing them into open discussion so that everyone will be more cognizant of the over-all picture.

"Getting specifically to the braking aspects pertinent to this discussion, the airport operator's point of view is one that has been on record through AOC, namely, that the runway lengths must remain static, consistent with the CAA and IATA.

"From the economic side, it becomes imperative that the industry make possible further study and research along the lines brought out in today's discussion.

"Recently, we went down to All American Engineering in Delaware to see what research they were doing. That company has a contract with the Navy to study and test devices for the braking of aircraft by ground mechanical means, and the engineers there are convinced that it is also entirely practical for large aircraft. From

(*Continued on page 52*)

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1. The names and addresses of the publisher, editor, managing editor, and business managers are: Publisher, Henry Publishing Company, 444 Madison Ave., New York 22, N. Y.; Editor, Mrs. J. Fred Henry, 444 Madison Ave., New York 22, N. Y.; Managing editor, Doris N. Ahnstrom, 444 Madison Ave., New York 22, N. Y.; Business manager, None.

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5. The average number of copies of each issue of this publication sold or distributed, through the mails or otherwise, to paid subscribers during the 12 months preceding the date shown above was: (This information is required from daily, weekly, semiweekly, and triweekly newspapers only.)

MRS. J. FRED HENRY

Sworn to and subscribed before me this 21st day of September, 1954.

STANLEY M. COOK

(SEAL)
(My commission expires March 30th, 1956)

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Skyways Round Table

(*Continued from page 51*)

work with a test model All American is satisfied that they can stop a large commercial airplane within 500 feet, which is a practical stopping distance. In addition to braking the airplane, another big problem is to develop an arresting device that will be applicable to all types of aircraft and all types of gear. The question is whether or not they can come up with a device or cable that will catch the aircraft's main gear but not be disturbed by the nose gear. In other words, as the nose gear passes over this cable, it trips a lever which instantaneously raises the cable that will catch the main gear, thus braking the aircraft. But the question is how do you allow for the varying heights of the fuselage of the different types of planes?

"I am certain that such a stop device will be developed, and it will prevent many serious accidents on over-run, where an airplane inadvertently has used up all the runway and needs deceleration quickly."

Summary

Harold Hoekstra: *"To summarize the discussion on braking, I believe we have established the importance of all of those systems in helping us to improve the stopping of aircraft, and also have proved that in a sense each system is mutually supplementary or complementary to the other.*

"Aerodynamic devices and power-plant reversing are usable at the high-speed end of the range, whereas braking devices operate more efficiently at the lower speeds.

"I think we can agree that the amount of deceleration we have in transports today (about two-tenths or three-tenths g's) is not reaching the point of discomfort to the passengers in those transports.

"One of the fundamental bases for the airport size and aircraft relationship is a stopping distance (without use of special techniques) of within 60% of the runway length, coming in over a 50-foot barrier at 1.3 times the stall speed. That premise undoubtedly will remain one of the fundamental points, but as we go along and develop new devices, there may be a gradual change in that requirement.

"The continuing development of the devices we have discussed here today should bring greater efficiency to military operations. In addition, and a very important one, they should provide civil aviation with greater safety while operating increasingly higher performance transports from airports meeting present standards."

Synthetic Oils

(*Continued from page 12*)

Other Requirements

Compatibility with various metals used in turbine design is important. In addition to the high temperature and corrosion-resistant ferrous alloys, modern practice includes copper and its alloys, silver, aluminum, magnesium and lead. Titanium and its alloys also are beginning to make their appearance. Use of cadmium and zinc is questioned at present because they frequently react with oxidation products and additives. The latter two metals are used largely for plating and corrosion protection of miscellaneous parts.

Volatility also is an important factor in the selection of a turbine lubricant. The objections found with highly volatile oils are serious lacquering, high oil consumption and loss of lubricant following shutdown of the turbine. This is one of the properties favoring the selection of synthetic oils.

Since all oil systems in aircraft collect small amounts of water from time to time, hydrolytic stability is an essential requirement. In addition to resistance to hydrolysis, a lubricant should not form a gel or solid material in the presence of water.

In some designs of turboprop engine a lubricating oil also serves as the hydraulic oil for propeller governing. The British experience thus far has found that kinematic viscosities below 7.5 cs @ 210°F. resulted in excessive leakage in the governor mechanism and poorer control over engine speed. This is not necessarily a hard and fast requirement and may change with new designs. It is not a factor where the prop carries an independent supply of hydraulic oil.

Bleeding air from the turbine compressor for cabin pressurization has introduced the question of toxicity. With this system of cabin pressurization any oil leakage into the compressor will, of course, result in vapors or oil mist entering the cabin. This problem is one of the most controversial at the moment. However, in the final analysis it may be stated the synthetic oil should not be more toxic than mineral oil.

(*Continued in January issue*)

Super -92 DC-3

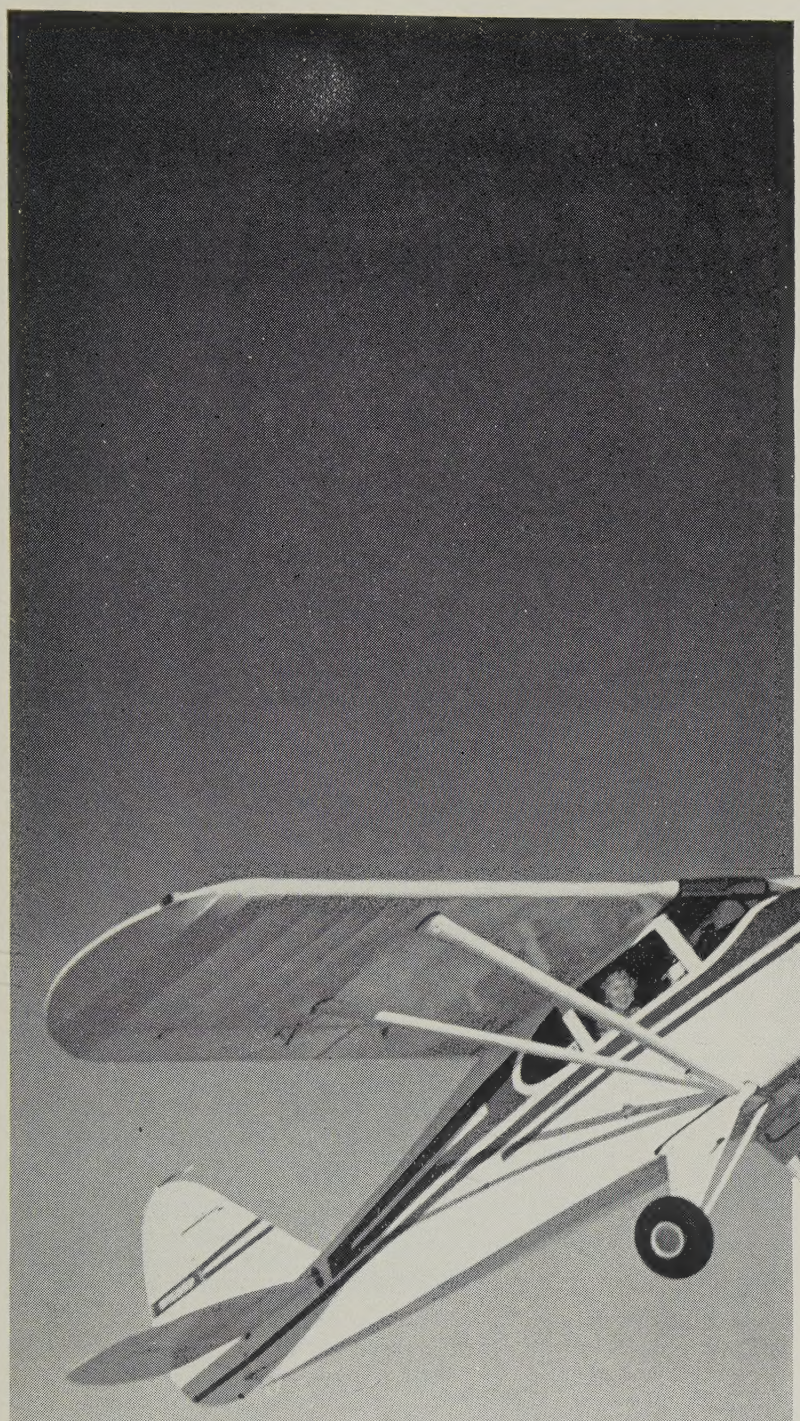
(*Continued from page 15*)

an extra 100% or more in operating costs. This is particularly true, he said, when it also means a sacrifice of 67% or more in space and walk-around room and the aircraft in question cannot get into many small airports.

The Super -92 sells for $179,000 and for that price Remmert-Werner is providing a DC-3 which meets the following specifications important to business:

Baggage capacity—½ ton; entrance—as easy as entering a house; take-off—short enough to use any recognized airport in the United States; rate of climb—faster than the average business man wants to climb without pressurization; speed—fast enough to make the average business trip in one day in comfort and with time for a nap; noise level—low enough for enroute business meetings or just plain sleeping; vibration—smooth enough to keep the gin rummy deck on the card table; short-field operation—good enough for almost any airport; range—two or three times the length of the average business trip; cost of maintenance—parts are still available at 25% of the manufacturer's original cost; availability—more than 6,000 still in active service; useful life—some DC-3's already have reached 65,000 hours; safety—unsurpassed.

While the industry is deciding who is going to finance and build the newer types of aircraft the business market must have, the rugged DC-3 continues to be a superb example of the "make-do" aircraft still available to the flying businessman.



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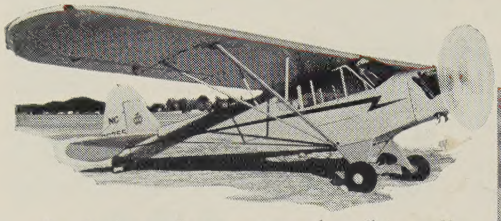
FLY WEATHER-WISE

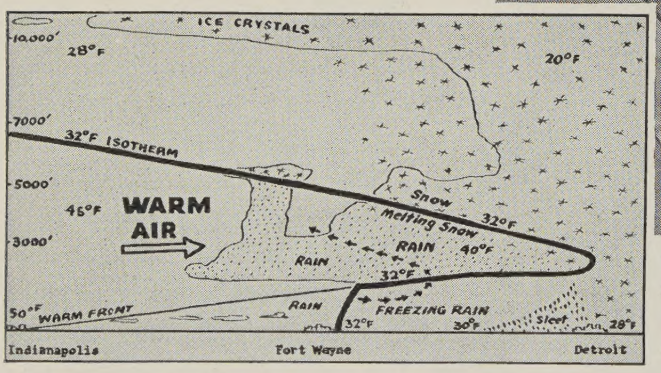
These weather items prepared in consultation with the United States Weather Bureau



Don't depend upon your take-off propeller blast to clear your wings of snow. Even dry powdery snow may have melted and refrozen underneath on the wing.

On the ground, get your plane into a hangar on cold, rainy days. A quick drop to near 32° F. will cause rain to freeze on impact with the wings.

Checking fog possibilities, study weather reports upwind from the station in question. If Dew Points are higher upwind, chances are the fog will increase when the wetter air moves in.



Under an overcast sky in light rain with temperatures near 32° F., freezing rain is apt to be encountered. If not equipped for all weather flying, land immediately. If this is not possible, try climbing to warmer temperatures in the over-running rain clouds.

Best Pair to Get You There

IN WINTER FLYING, it's wise to prepare for the worst...and hope for the best. One smart preparation step is to select the right aviation products. Mobilgas Aircraft and Mobiloil Aero have long been the first choice of experienced pilots. These famous Flying Red Horse products have proved their performance standards in outstanding aviation events from the days of Kitty Hawk to recent Jet Age exploits. Fly safely ...fly with the Flying Red Horse.

Mobiloil AERO

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